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INDEX

Angiocardiographic mixing defects as indicators of left to right shunts. By *Melvin M. Figley, Björn Nordenström, Aaron M. Stern* and *Herbert Sloan* . 425
Cholegraphic signs of acute biliary stasis. By *Georg Theander* 438
Arteriomesenteric obstruction of the duodenum in adult life and adolescence. By *Erik de Fine Licht* 441
Blood pressure and heart rate during angiocardiography, abdominal aortography, and arteriography of the lower extremities. By *A. K. Amundsen, P. Amundsen* and *O. Müller* 452
Roentgenologic findings in the stomach and duodenum in cancer of the pancreas, By *Kaare A. Larsen* and *Arne Pedersen* 459
A compressor for use in foetal roentgenography. By *Paul Edholm* 470
A simple instrument for urethrocystography and fistulography in adults and children. By *Åke Gullmo* 473
Some practical aids in routine work. By *Ove Mattsson* 479
Die Behandlung maligner Testistumoren am Radiumhemmet, Stockholm. Von *Gustaf Notter* 483
Periodic control of the function and constancy of ionization chamber dose meters. By *R. Thoraeus* 503

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EDITA IUSSU SOCIETATUM RADIOLOGICARUM
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VOL. 45 JUNE 1956 FASC. 6

ANGIOCARDIOGRAPHIC MIXING DEFECTS AS INDICATORS OF LEFT TO RIGHT SHUNTS

by

Melvin M. Figley, Björn Nordenström, Aaron M. Stern and *Herbert Sloan*

Those familiar with venous angiocardiography are aware of areas of non-uniformity in the concentration of contrast material due to incomplete mixing of the material and non-opaque blood. Such mixing defects are regularly observed at the entrance of venous tributaries into the major veins and in the right atrium opposite the vena caval orifices. At other locations such mixing defects are abnormal. In the right heart and pulmonary artery they may indicate left to right shunts. Isolated examples of mixing defects caused by such shunts have been published (3, 7, 8, 10, 11), but we have not encountered a systematic survey of this aspect of angiocardiography. For this purpose we have re-examined the angiocardiograms of 75 patients with verified left to right shunts. Cardiac catheterization evidence of a left to right shunt through atrial and ventricular septal defects and anomalous pulmonary veins was required before inclusion in this study. Patent ducti were all verified surgically, a few having had catheterization preoperatively.

Method

The following angiocardiographic technique was used. Contrast material, either Diodrast 70 % or Urokon 70 %, was injected manually as rapidly as possible in a peripheral vein in amounts of 1 ml per 1 kg body weight. General anesthesia was not used. Infants and children were examined recumbent; adults, upright. Choice of projection was not uniform and for the purpose of this study proved disadvantageous in some

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From the Departements of Radiology, Pediatrics, and Surgery, University of Michigan, Ann Arbor, U. S. A.

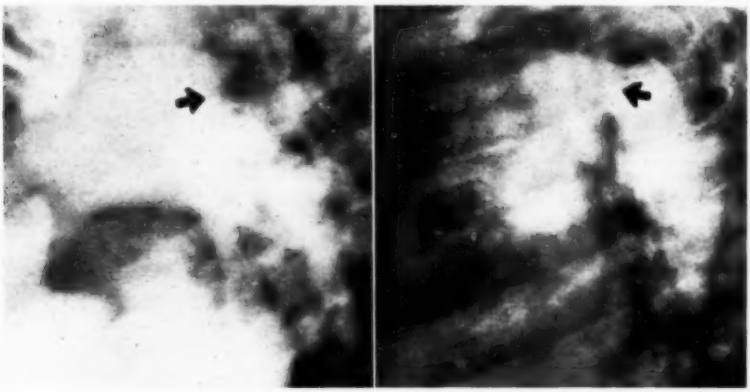

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Fig. 1. Patent ductus arteriosus. Female, 2 yrs. a. Lateral projection of main pulmonary artery with small mixing defect (arrow) at the origin of the left branch. b. Retrograde aortography demonstrates the wide patent ductus (arrow) opacifying the pulmonary artery in the region of the mixing defect.

instances. Films were obtained in one plane at 2 per second, lately with electrocardiographic control. Exposure times varied from 1/60 second in infants to 1/10 second in adults.

Observations and Critique

Patent ductus arteriosus. The normal pulmonary artery and its major branches are uniformly opacified and fairly sharply marginated by venous angiocardiography. A left to right shunt through a patent ductus allows displacement or dilution of the contrast material in the artery by the jet of non-opaque blood from the aorta. The resulting mixing defect may be limited to the region of the ductus near the bifurcation of the artery (Fig. 1), or it may extend all the way down to the pulmonary valve so that a large gap in opacification appears between the right ventricular outflow and the larger pulmonary branches (Fig. 2).

The mixing defect is seen best in lateral or oblique projections. The axial view of the pulmonary artery in frontal projection is disadvantageous. Defects have been obscured in this projection when they were visible in the lateral.

Of special interest is the time of occurrence of the mixing defect. In the majority of cases it has been recognized only during ventricular diastole. When recognized in systole, it has always been less conspicuous. In 9 cases with electrocardiographic control, the defect was visualized in each in ventricular diastole, but only three times in systole. Reversal

of the shunt during systole, a manifestation of pulmonary hypertension, has been seen on two occasions (Fig. 3). LIND et coll. (8) and GRAMIAK et coll. (4) have also emphasized the predominant diastolic occurrence of the mixing defect.

Two factors would appear to govern the possibility of recognition of this mixing defect; the volume of the shunt and the adequacy of the examination. The volume of the shunt is determined by the size of the ductus and the pressure gradient between the aorta and pulmonary artery. It is roughly indicated by the pulmonary artery-right ventricular oxygen content difference. This was measured in only a few of our patients by catheterization prior to ligation of the ductus. The data in Diagram 1 suggests no relation between visible mixing defect and volume of the shunt, although there may be some relation to the pulmonary arterial pressure. It is known that some patients with pulmonary hypertension have small left to right or predominant right to left shunts (9). These might be expected to have no recognizable mixing defect. It was assumed that the other patients with-

Fig. 2. Patent ductus arteriosus. Male, 3 months. Lateral projection of right heart chambers. Large mixing defect between the pulmonary valve and the branching of the main pulmonary artery.

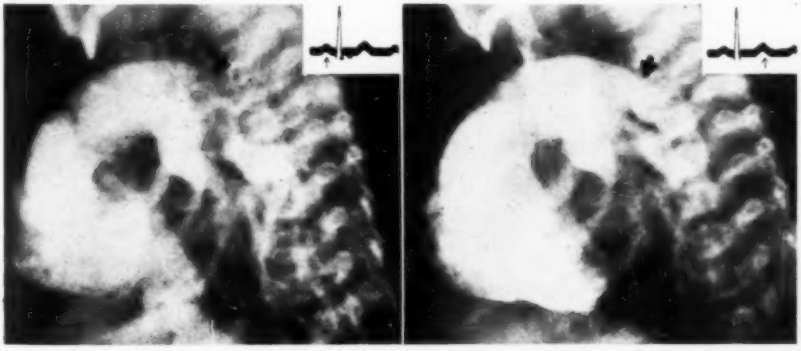

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Fig. 3. Patent ductus arteriosus. Male, 5 months. a. Lateral projection of right heart in ventricular diastole. Mixing defect (arrow) at origin of left pulmonary artery. b. During ventricular systole the shunt is reversed and a very wide patent ductus is shown. Cardiac arrest occurred with attempts to close the ductus.

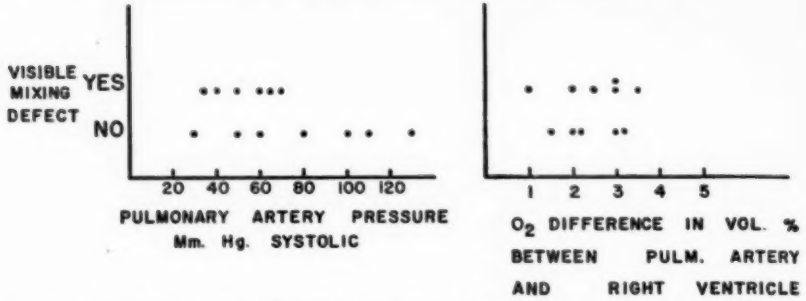

Diagram 1. Patent ductus arteriosus. Relation of visibility of mixing defect to pulmonary artery pressure and oxygen difference between pulmonary artery and right ventricle. Tendency for mixing defects to be seen with lower pulmonary pressures but no relation to oxygen difference.

out catheterization, being acyanotic, had predominant left to right shunts, but we have no laboratory evidence to prove this.

The adequacy of the examination at times left something to be desired, having been limited to frontal projection or marred by slow injection or long exposures. Two films per second also may have the disadvantage of being synchronous with the heart rate so that all films are exposed in the same part of the heart cycle. Should the exposure

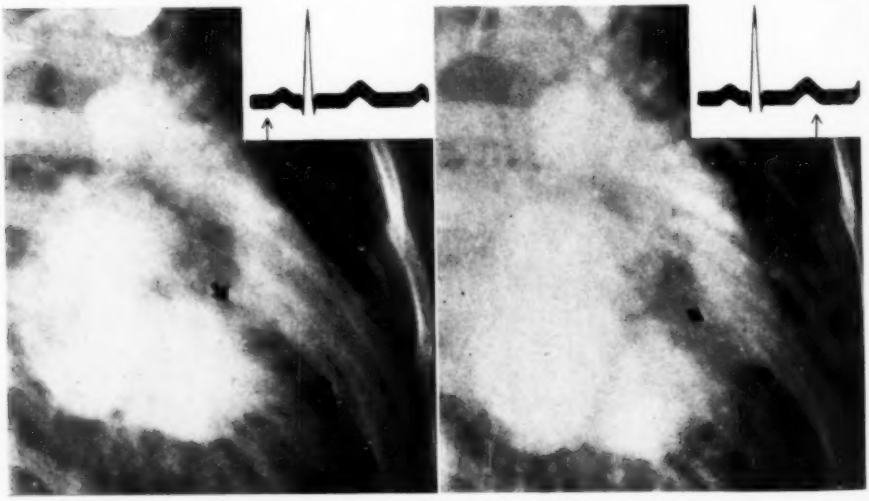

Fig. 4. Ventricular septal defect. Male, 6 yrs. Right anterior oblique projection of right heart chambers. Small mixing defect in the right ventricle (arrows) in both ventricular diastole, left, and ventricular systole, right.

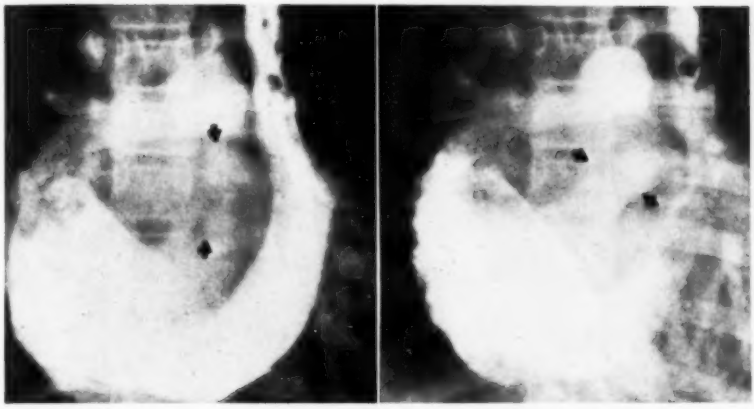

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Fig. 5. Ventricular septal defect. Female, 9 yrs. A. p. projection of right heart filling from left superior vena cava. a. Mixing defect in the right ventricular outflow tract below the pulmonary valves. b. Opacification of the same region with another exposure.

instant not be in ventricular diastole, the mixing defect of a patent ductus may be missed.

With these considerations in mind we selected those patients with patent ductus who had average to excellent angiocardiograms in oblique or lateral projection and in whom there was no clinical, catheterization or angiocardiographic evidence of dominant right to left shunt. Mixing defects in the pulmonary artery were recognized in 17 of 25 cases. It would appear that there is a high probability of finding a mixing defect due to ordinary patent ductus by properly executed venous angiocardiography. This is contrary to our previously stated opinion (10).

Ventricular septal defect. A shunt of non-opaque blood from the left ventricle through the ventricular septum may be expected to displace or dilute contrast in the region of the defect or in the right ventricular outflow tract and pulmonary artery above it. We have recorded small mixing defects in the sinus or inflow portion of the right ventricle (Fig. 4), more often in the outflow tract (Fig. 5), and on one occasion found a large mixing defect extending from near the tricuspid valve into the base of the pulmonary artery (Fig. 6). These have been best seen in the frontal, lateral, or right anterior oblique projections. The left oblique view often suffers the disadvantage of superimposition of right atrium and ventricle.

The timing of these mixing defects is interesting. As might be expected these were visualized during ventricular systole, but on at least

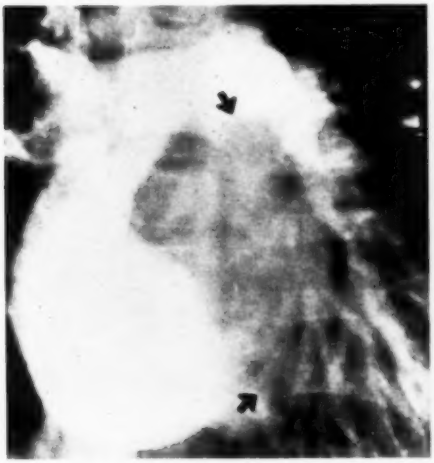

Fig. 6

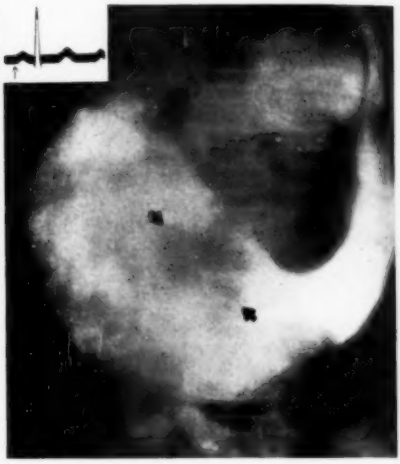

Fig. 7

Fig. 6. Ventricular septal defect. Female, 4 yrs. A. p. projection. Large mixing defect in the body and outflow portion of the right ventricle extending into the pulmonary artery.

Fig. 7. Atrial septal defect. Female, 4 yrs. A. p. projection of right heart during atrial diastole filling from a left vena cava. Mixing defect in the right atrium (arrows) with interruption of opacification in the atrial margin just above, possibly indicating the location of the atrial septal defect.

four occasions a mixing defect was seen during ventricular diastole, suggesting some movement of blood across the septum during the inactive period of the ventricles. Presumably small differences in ventricular diastolic pressure, perhaps influenced by atrial systole, account for this movement.

The recognition of mixing defects due to ventricular shunts, as in patent ductus, is governed by the quality of the examination. It is made more difficult by the changing size and shape of the right ventricle during the heart cycle. Occasionally the normal right ventricular outflow tract contains little or no contrast at the end of ventricular systole, at least as seen in frontal projection (12). This possibility adds uncertainty to the recognition of mixing defects at this period, although it does not apply to ventricular diastole when the outflow tract is always distended.

The patients chosen for this study all had left to right ventricular shunts as determined by catheterization, although the volume of the shunts was not determined. The right ventricular pressure varied widely. It might be expected to reduce or reverse the left to right shunt as it

Fig. 8

Fig. 9

Fig. 8. Atrial septal defect. Male, 11 yrs. Lateral projection of right atrium. Mixing defect in posterior portion of the atrium (arrows) preventing definition of the atrial wall between the two venae cavae.

Fig. 9. Total anomalous pulmonary venous drainage into left innominate vein. Male, 5 yrs. A. p. projection. Mixing defect (arrows) at the insertion of left superior vena cava carrying pulmonary venous return into the left innominate vein.

approached the systemic pressure. For assessment of the possibility of recognizing these shunts by angiocardiography, we excluded those with inadequate examinations by reason of filming technique, left anterior oblique projection, or right to left ventricular shunt by angiocardiography. In the remaining 18 cases a mixing defect in the right ventricle was found in only 7. Five others had questionable mixing defects.

Atrial septal defect. Unlike other left to right shunts, the recognition of those through atrial septal openings is not so straightforward since the right atrium also receives other streams of non-opaque blood from the coronary sinus and the opposite vena cava. In consideration of this fact we are reluctant to accept mixing defects in the right atrium as indicative of atrial left to right shunts unless these tributaries, especially the opposite vena cava, are also opacified. Likewise all portions of the atrium must be visible. Incomplete mixing with residual non-opaque blood in the atrium is often seen as contrast first enters the atrium. For this reason the diagnosis of tricuspid valve incompetence as described by DOTTER et coll. (1), on the basis of a right atrial mixing defect near the valve, has seldom seemed warranted in our material.

Our experience is limited to 21 patients with catheterization evidence

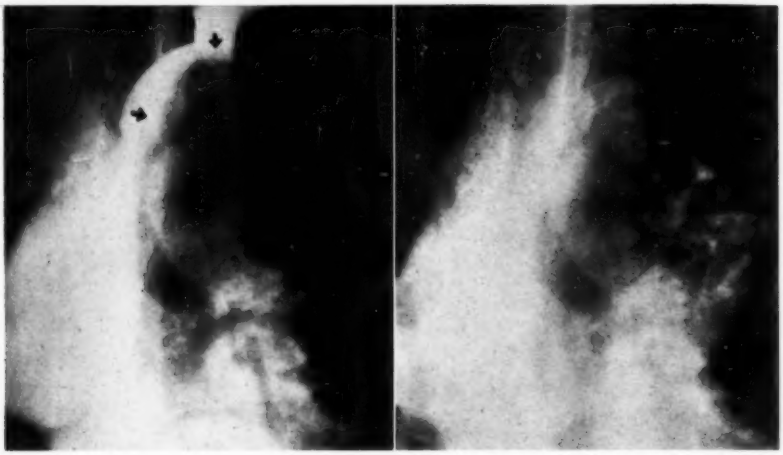

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Fig. 10. Total anomalous pulmonary venous drainage into left innominate vein. Female, 27 yrs. A. p. projection. a. Opacification of left innominate vein and greatly dilated right superior vena cava. Mixing defect (arrows) at insertion of left superior vena cava. b. Later opacification of left superior vena cava from pulmonary veins.

of atrial left to right shunts. In this latter group only 3 cases showed right atrial mixing defects that, with the above consideration, could be ascribed to the shunt. These were seen in frontal (Fig. 7) and lateral (Fig. 8) projections. In 2 cases with electrocardiographic control they were recorded during atrial diastole.

In assessing the likelihood of recognition of an atrial left to right shunt by a mixing defect, it would seem reasonable to exclude those cases with right to left shunt as shown by angiocardiograms. In the remaining 13 cases with uncomplicated atrial left to right shunts, seemingly diagnostic mixing defects were found in only 3.

Anomalously inserted pulmonary veins. Venous mixing defects are normally seen at the entrance of the jugular veins into the innominates, the azygos and innominate into the superior vena cava, and the iliac, renal and hepatic veins into the inferior vena cava. Elsewhere mixing defects are abnormal and may serve to identify anomalously connected pulmonary veins.

The largest and most obvious of these are seen with total anomalous pulmonary venous drainage into a persistent left superior vena cava which drains into the left innominate vein (Figs. 9 and 10). Three patients with partial anomalous pulmonary venous drainage were studied. One

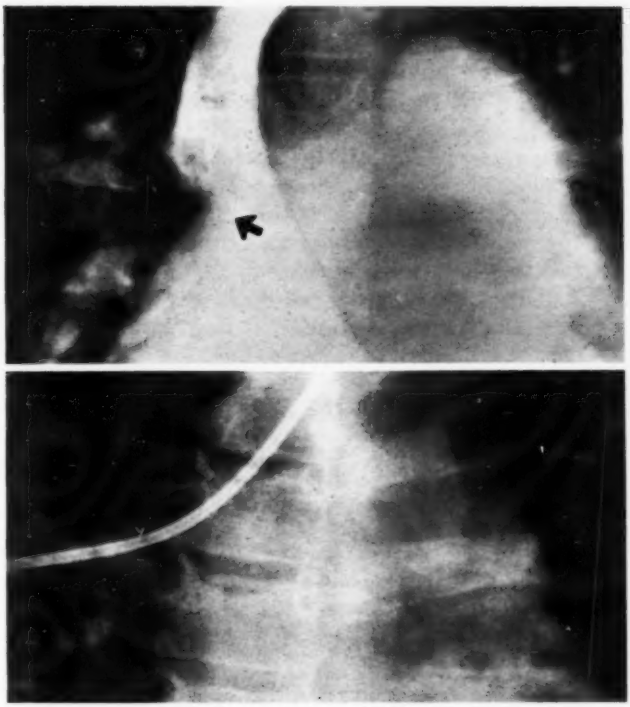

Fig. 11. Partial anomalous venous drainage into superior vena cava. Male, 8 yrs. *Above:* A. p. projection of contrast entering right atrium from superior vena cava. Mixing defect (arrow) prevents definition of right lateral wall of the vena cava. *Below:* Catheterization of right pulmonary vein from the superior vena cava.

showed a superior vena caval mixing defect (Fig. 11). On occasion normal venous tributaries are directly seen by a brief reflux during injection, but we have not recorded this in anomalously connected pulmonary veins.

Discussion

Until recently the recognition of left to right shunts by venous angiocardiography has depended upon the detection of recirculation of contrast through the lungs. Selective chamber enlargement and recirculation in certain chambers helps to localize the shunt. But precise localization with this evidence alone is not always possible. The observation of a specific sign such as one of the mixing defects we have described is then an obvious advantage.

Unfortunately, however, these mixing defects are not consistently observed. With the exception of those due to patent ductus, they represent only a refinement of angiocardiographic interpretation and do not obviate the necessity for catheter investigation of suspected left to right shunts.

In regard to patent ductus, because of their frequent detection, they have more practical significance, particularly in infants in whom both clinical diagnosis and cardiac catheterization may be difficult and indecisive. They provide a specific sign with which surgical treatment may be confidently undertaken. For two infants in heart failure, the observation of mixing defects was the decisive factor in the recognition of patent ducti that were subsequently ligated with great benefit to the patients. In our other patients mixing defects have not had such a vital rôle, but the experience with these two patients has led us to use venous angiocardiography in many infants in whom a patent ductus cannot be diagnosed or excluded.

The differing incidence of observation of mixing defects requires explanation which we are not able to provide completely. It should be realized that only unequivocal, sharply demarcated defects were accepted. Often it was clear that dilution was occurring, but mixing defects were not seen. In the right atrium the difficulty of excluding the mixing defect from the opposite vena cava is the principal problem. In the right ventricle changing shape and rapid motion seem to be the main difficulties. More rapid filming and shorter exposures would certainly be expected to improve our results, particularly ultra-short exposures in the range of 1 millisecond as recently described by DOTTER and ROGERS (2). Although better equipment may not be the entire answer, it would seem to be an important part since these mixing defects are simply the radiographic manifestations of shunts that are known to exist. In this connection, however, it should also be mentioned that other methods of roentgenologic examination, *e. g.* selective angiocardiography, generally can be applied for an accurate diagnosis with detailed visualization of the anatomic defects through which these shunts are occurring.

The literature records most of the observations we have described, but it is clear that the diagnostic value of mixing defects is not widely appreciated. GOETZ (3) in 1951 apparently was the first to point out the defect due to patent ductus arteriosus — his 'jet sign'. GRAMIAK et coll. (4), working with cine-angiocardiography observed diastole dilution in the pulmonary artery to be indicative of patent ductus in 10 verified cases. Most recently available is the monograph by the cardiologic team of Karolinska Sjukhuset describing and illustrating mixing defects due to patent ductus and ventricular septal defect (7). ZDANSKY (13) presented a mixing defect due to atrial left to right shunt. STEINBERG (11) has

illustrated and KJELLBERG et coll. (7) have mentioned the possibility of a venous mixing defect due to an anomalously inserted pulmonary vein.

The first to recognize the general principle of dilution and mixing defects as the result of left to right shunts were LIND et coll. (8). Their electrocardiographically timed films show such shunts through patent ductus during ventricular diastole, through ventricular defects during ventricular systole, and through atrial defects during atrial systole.

It would seem possible to extend the principle and to prepare a classification of left to right shunts, both congenital and acquired, on the basis of the position of the mixing defect (Table I). To go further, dilution defect by right to left shunts may be seen during left heart opacification. We have noticed this in the post ductal portion of the aorta in a case of 'reversed ductus' (10), and would expect to encounter mixing defects in selective left heart opacification.

Table I

Classification of left to right shunts

Site of mixing defect	*Abnormal communication*
Great veins	Abnormally inserted pulmonary veins
	Aortic-vena caval fistula (aneurysm)
	Acquired arteriovenous fistula
Right atrium	Atrial septal defect
	Abnormally inserted pulmonary veins
	Aortic sinus Valsalva fistula
Right ventricle	Ventricular septal defect
	Aortic sinus Valsalva fistula
Pulmonary artery	Patent ductus arteriosus
	Aortic-pulmonary septal defect
	Acquired aortic-pulmonary fistula (aneurysm)

From the isolated view of angiocardiographic interpretation, intraluminal masses may produce filling defects that need to be distinguished from mixing defects due to shunts. Neoplasm may invade the great veins or arise in the atria. We have recognized thrombi in both right and left atria and have seen a large filling defect in the pulmonary artery due to encroachment by aneurysm of the ascending aorta. When clinical features are considered, however, mass lesions will seldom be confused with mixing defects due to shunts.

Lastly the possibility of incomplete physical dispersal of the contrast has to be considered. The introduction of high specific gravity contrast into slowly moving blood allows layering phenomena well described by KJELLBERG (6) and GREITZ (5) that are best appreciated with the beam

horizontal. At angiocardiography multiple inconstant defects may be seen in the vena cava in cases with heart failure and pericardial constriction presumably due to slow venous flow, but we have never observed layering except in superior vena caval obstruction. The turbulence in the vena cava and right atrium generally seems adequate to produce complete mixing, for mixing defects have not been observed in the right ventricle or pulmonary artery in the absence of a shunt or intraluminal mass by the angiocardiographic technique described here.

This investigation was carried out during dr. Nordenström's tenure of a James Picker Foundation fellowship in radiological research. It was also supported by the John and Mary R. Markle Fund and the Michigan Heart Association.

We are indebted to Mr. ROBERT W. S. LEE for his invaluable assistance in determining the oxygen content of the blood samples obtained at cardiac catheterization.

SUMMARY

Defects in the mixing of contrast material and blood may be seen by venous angiocardiography as the result of congenital intra- and extracardiac left to right shunts. The location of the mixing defect provides an angiocardiographic evidence of the underlying anatomic abnormality. Such mixing defects are not seen frequently in patients with catheterization evidence of atrial or ventricular septal defects, but they commonly occur with patent ductus. For this reason venous angiocardiography in infants may be utilized in searching for patent ductus. Factors that control visualization of mixing defects such as radiographic technique, projection and timing, the volume of the shunt and right ventricular pressure are discussed. Of these, the radiographic factors seem most important.

ZUSAMMENFASSUNG

Mangelhafte Mischung des Kontrastmittels mit dem Blute kann bei der venösen Angiocardiographie als das Ergebnis eines kongenitalen intra- und extrakardialen links-rechts Shuntes gefunden werden. Die Lokalisation des Mischungsdefektes gibt einen angiocardiographischen Beweis der zu Grunde liegenden anatomischen Anomalie. Derartige Effekte werden bei Patienten, bei denen der Nachweis von Vorhof- oder Kammerseptumdefekten durch Katheterisierung gebracht wurde, nicht oft gesehen; sie treten jedoch häufig beim offenstehendem Ductus Botalli auf. Aus diesem Grunde kann die venöse Angiocardiographie bei Kindern zur Suche nach einem offenstehenden Ductus Botalli benutzt werden. Faktoren, welche die Sichtbarkeit der Mischungsdefekte kontrollieren, wie die röntgenologische Technik, die Projektion, die Exponierungszeit, das Volumen des Shunts und der Druck in der rechten Kammer, werden diskutiert. Unter diesen scheinen die radiographischen Faktoren am wichtigsten zu sein.

RÉSUMÉ

On peut observer des défauts de mélange du produit de contraste et du sang dans l'angiocardiographie veineuse, qui sont dus à des shunts congénitaux de gauche à droite, intra- ou extracardiaques. Le siège du défaut de mélange fournit une preuve angiocardiographique de l'anomalie anatomique. On ne voit pas fréquemment ces défauts de mélange chez les malades chez qui le cathétérisme prouve l'existence d'une communication interauriculaire ou interventriculaire, mais ils sont communs dans les cas de persistance du canal artériel. C'est pourquoi l'angiocardiographie veineuse peut être utilisée chez les

nourrissons pour rechercher la persistance du canal artériel. Les auteurs examinent les facteurs dont dépend la visualisation des défauts de mélange, tels que la technique radiographique, l'incidence et le rythme, le volume du shunt et la pression ventriculaire droite. Parmi eux, les facteurs radiologiques semblent les plus importants.

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CHOLEGRAPHIC SIGNS OF ACUTE BILIARY STASIS

by

Georg Theander

This paper is concerned with a report of 2 cases of biliary colic in which cholegraphy revealed intermittent biliary stasis as indicated by retarded contrast-filling or by non-filling of the biliary ducts during the attacks. It appears that these cholegraphic signs have hitherto passed unnoticed.

Case 1. A woman, aged 58, had been operated on in November 1953 for acute exacerbation of chronic cholecystitis and cholelithiasis with peritonitis. Surgical exploration revealed purulent cholecystitis and severe inflammation of the cystic duct. The gallbladder was incised and, after the removal of 8 stones, a drainage tube was inserted. On 27 November cholangiography with injection of the contrast medium

a b

Fig. 1. Concretion in the common bile duct a) during remission, b) during colic; the stone is situated more distally and contrast-filling of the biliary ducts retarded.

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through the tube revealed a non-opaque stone in the common duct. The biliary tree was slightly dilated. After removal of the tube, cholegraphy was performed on 4 and 7 December 1953, and on 21 January and 2 February 1954, films being taken at least every 10 minutes after the injection of Biligrafin. On all of these occasions the bile ducts were visible within 10 minutes of the injection, but the gallbladder was never shown. The stone was lodged in the common bile duct at a level about 2 cm from its duodenal end and 1.5 cm below the union of the cystic duct with the common bile duct (Fig. 1 a). The postoperative course was smooth until 8 February when biliary colic occurred. Cholegraphy during the attack showed that the stone had migrated further distally in the common bile duct (Fig. 1 b) and that now the ducts were not demonstrable until 20 minutes after the injection of Biligrafin. Since re-operation (cholecystectomy and choledocholithectomy) on 11 March 1954, the patient has been symptom-free.

Case 2. A woman, aged 28, had been subjected to cholecystectomy on 13 June 1952, because of a solitary gallbladder stone and a short history of biliary colic. Cholangiography during the operation showed no residual stones, and the ducts were of normal width. After operation the patient complained of frequent severe attacks of abdominal pain. Her description of the pain was not quite typical of biliary disease, and she had no jaundice. Cholegraphy with Biligrafin on 21 December 1953, showed no signs of a pathologic condition (Fig. 2). At re-examination during an attack on 30 March 1954, however, no contrast medium was demonstrable in the bile ducts or intestines. The patient was examined again on 7 April; she was then symptom-free and the cholegram was of normal appearance. The cholegraphic findings, which thus showed that the colic was related to an intermittent hepato-biliary disorder, were taken as evidence of biliary dyskinesia, for which transduodenal papillotomy was performed on 7 April; since then the patient has been symptom-free.

Fig. 2. Cholegraph showing no signs of pathologic condition during remission in post-cholecystectomy syndrome. On cholegraphy during colic, however, no contrast medium was demonstrable in biliary ducts or intestines.

Discussion

Several authors have stressed that cholegraphy is a suitable method for examination of the biliary ducts, not only for anatomic lesions but also for disorders of function. Thus, retardation of the flow of contrast medium into the duodenum and widening of the biliary ducts are considered suggestive of biliary stasis (Hornykiewytsch & Stender 1953, Gaebel & Teschendorf 1954, Feine 1955, et al.). No attention, however, seems to have been paid to the retardation or absence of visualization of the biliary ducts as exemplified by the 2 cases now reported.

These cholegraphic signs of biliary stasis might be considered analogous with the signs of urinary stasis in excretory urography; they are,

however, more difficult to demonstrate and to evaluate. In urography, even a slight deviation from the normal rate of excretion of the contrast medium is, as a rule, obviously demonstrable by comparison with the fellow kidney. On the other hand, in cholegraphy, which is concerned with a single organ, even an apparently marked delay in the excretion of the contrast medium must be judged with caution because of the wide range of normal variations. It should also be stressed that conclusive evidence of biliary stasis is obtained by cholegraphy only by comparison of the observations during attacks with those made during remissions.

It is obvious that utilization of the possibilities of intravenous cholegraphy to demonstrate biliary stasis places large demands on the radiologic department and requires intimate cooperation with the departments referring the patients for examination. Though biliary colic may occasionally be artificially produced at any convenient time by the ingestion of provocative foodstuffs or by the injection of morphine, investigation of most cases requires a 24-hours radiologic service to permit immediate examination during spontaneous attacks occurring at any time of the day or night.

SUMMARY

Two cases are reported in which intermittent biliary stasis was demonstrated cholegraphically by delayed contrast-filling and by non-filling of the biliary ducts during colic

ZUSAMMENFASSUNG

Zwei Fälle werden rapportiert, bei denen intermittente Gallenstauung cholezystographisch auf Grund verzögerter Kontrastfüllung und auf Grund der Unsichtbarkeit der Gallengänge während des Anfalles demonstriert wurde.

RÉSUMÉ

Présentation de deux cas où la stase biliaire intermittente a été démontrée cholégraphiquement par une visualisation retardée et par l'absence de visualisation des canaux biliaires pendant une colique hépatique.

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ARTERIOMESENTERIC OBSTRUCTION OF THE DUODENUM IN ADULT LIFE AND ADOLESCENCE

by

Erik de Fine Licht

Arteriomesenteric obstruction of the duodenum is well known in the radiologic literature, not least through the studies published by LADD (5). A distinction is made between 'intrinsic' and 'extrinsic' occlusions. In the vast majority of cases reported, the patients suffered from acute or subacute conditions which necessitated surgical measures.

In the earlier surgical literature, numerous cases of arteriomesenteric obstruction of the duodenum in adults and adolescents are on record, whereas such reports are sparse or obscure in the radiologic literature and textbooks of radiology. However, a relatively large number of patients undoubtedly suffer from this disorder. In 1929, several cases were published by BOCKUS (1), and ROMAGOSA and MENVILLE (7) reported a roentgenologically diagnosed case in 1951. Little mention has been made of the condition in the Scandinavian literature. In 1952, RATJEN (6) published a case, associated with marked oesophageal dilatation, from this hospital. BOCKUS wrote that the duration of symptoms may vary from 24 hours to a whole life. The ages of his patients ranged from 24 to 66 years, and two of them dated their condition back to early childhood.

The symptoms I have observed in a number of patients are identical with those described by BOCKUS and ROMAGOSA. The principal manifestations are fullness, belching, discomfort or depression after meals, a sensation of abdominal heaviness, and abdominal rumbling often accompanied by severe pain, particularly after meals. In addition, toxic symptoms such as headache, nausea, and vertigo may be present. Some patients are below their normal weight and are emaciated.

Among the patients described by BOCKUS there were some with up

Read in a slightly modified form at the meeting of the Danish Radiologic Society, 29 October 1955; submitted for publication 22 February 1956.

to 24 hours' duodenal retention, cases which would now be interpreted as being due to severe malrotation, and which are well known to-day, in this country particularly, from WINKEL SMITH's descriptions (8). BOCKUS did not mention malrotation as a causative factor; on the whole, it may be said that he to some extent mixed up the possible causes of the condition.

In the present paper I intend to consider especially the milder forms of arteriomesenteric obstruction, which in my opinion are of particular interest from the radiologic point of view.

In the Department of Radiology of this hospital we have observed arteriomesenteric obstruction in a number of adult and adolescent patients with marked clinical symptoms, but without abnormal disposition of the abdominal viscera. The roentgenologic changes consist in dilatation of the duodenum up to the duodenojejunal flexure with reversed peristalsis in the dilated portion, especially in the descending part of the duodenum, and with abnormally violent kneading of the intestinal contents in the dilated region. There may be some stasis, as the contents do not pass on at once but may remain in the duodenum for 10 to 20 minutes or even longer in severe cases. Although a rare occurrence, signs of gastric dilatation may occasionally be evident. In some patients these findings are constantly present on repeated roentgen examinations, whereas the occlusion is more intermittent in others. The clinical symptoms are highly variable. A feature which is common in most patients is pain developing rapidly after meals, especially if these have been large. The pain is often relieved if the patient assumes the prone or knee-elbow positions, an observation made in most papers on the condition. Three of our female patients exhibited severe 'nervous' anorexia.

This anorexia has been explained in many different ways in the literature. It is possibly due to an unconscious sensation of discomfort brought about by eating; owing to the discomfort promptly following the ingestion of food, the patient instinctively reduces his meals to totally insufficient amounts. In such patients the past history is often obscure, and the clinical picture may reveal features which must be considered to be effects rather than causes of the anorexia.

A few case reports are given below.

Case 1. An unmarried woman, aged 38, was admitted to Niels Steensen's Hospital from 20 Nov. to 6 Dec. 1954. Her past history had been of good health up to the age of 18 years, when her menstruations failed to appear for 12 months; at the same time she gained 15 kg in weight within 3 months. She became terrified at the weight gain, applied for medical aid and was given thyroidin because the basal metabolic rate was — 20. A reduction in weight was rapidly attained, but the patient continued to take thyroidin for the next 20 years, 3 tablets No. 2 daily. Up to 1939, when she was 23 years old, the patient felt quite well, but then her menses again ceased. She was admitted to Frede-

Fig. 1. A. Case 1. Woman, aged 38, with anorexia and arteriomesenteric obstruction, small diverticulum of duodenal bulb. Confirmed at operation. B. Case 2. Man, aged 30, with arteriomesenteric obstruction. Confirmed at operation. C. Case 3. Woman, aged 32, with arteriomesenteric obstruction. Confirmed at operation. D. Girl, aged 15, with anorexia and arteriomesenteric obstruction. No operation (polygram).

riksberg Hospital; menstruation was restored by administration of oestradiol benzoate and chorionic gonadotrophin. Her menses again ceased in 1942, but menstrual bleedings were restored in 1952 by administration of equine gonadotrophin and chorionic gonadotrophin. In 1945 a physician made a diagnosis of nervous anorexia, and the patient was admitted to a neuromedical hospital, where her disease was also suspected to be of nervous origin. She was treated with insulin and insulin shock, which she did not tolerate. From

1940 to 1950 her weight was approximately 50 kg; on admission in 1954 it had decreased to 38 kg.

Physical examination revealed a poorly nourished woman resembling a prisoner from a concentration camp. She was quiet and emotionally well-balanced. The clinical picture was dominated by her anorexia. She was unable to take any food in the presence of others and stated that this complaint had been very marked when she had been to parties.

Roentgen examination (1 Dec. 1954) revealed considerable dilatation and stasis of the duodenum with strong reversed peristalsis; considerable intestinal obstruction seemed to be present at the duodenojejunal flexure (Fig. 1 A), but distal to the flexure conditions appeared to be normal. The caecum was normal in position. A small diverticulum was observed at the duodenal bulb. Operation at the Rigshospital (WINKEL SMITH, 6 Dec.) confirmed the radiologic findings. Duodenojejunostomy was performed, following which the condition of the patient improved considerably. She is now fully recovered and has gained weight almost continuously. A follow-up examination on 18 Oct. 1955, showed good function of the anastomosis, and there were no signs of dilatation of any part of the duodenum or small intestine.

Case 2. An unmarried man, aged 30, was admitted to the Department of Surgery A of this hospital from 12 April to 19 April and again on July 3, 1955.

He gave a three-year history of marked dyspeptic discomfort with epigastric pain occurring at all hours of the day and night. He had not vomited, but had often had a feeling as if the intestinal contents returned to the stomach, accompanied by abdominal rumbling. Relief was obtained when the patient assumed the prone position.

Roentgen examination revealed dilatation of the duodenum with stasis and reversed peristalsis (Fig. 1 B). The abdominal viscera were in normal position. A control examination later showed unchanged conditions. The patient was discharged for further observation in the out-patient department. Following an attack of severe pain, a further examination 29 June still showed unchanged conditions, and the patient was re-admitted for surgical treatment. Roentgen examination showed exactly the same conditions as before, and the patient was then subjected to operation which revealed dilatation of the duodenum down to the duodenojejunal junction. The dilatation increased in degree distally, was very considerable at the duodenojejunal flexure, and then suddenly ceased. There were no adhesions in the surrounding tissue which could explain the lesion. Duodenojejunostomy was performed, but before the anastomosis was closed, an examining finger was passed into the lumen, where the superior mesenteric artery could be felt, running across the duodenum like a cord. A biopsy specimen of duodenal tissue was secured in order to ascertain if the usual nerve cells were present (JØRGEN LUND). Histologic examination of the specimen showed normal conditions (SØEBORG OHLSEN).

In addition to Case 1 our series comprises two women with marked anorexia. One of them has been subjected to operation, while the other is still treated conservatively although it is believed that surgical measures will ultimately become necessary (Fig. 1 D). However, features like those reported in Case 2 are predominant among our patients. In several of them, the morbid condition dates back to early childhood, manifested by distress during and immediately after meals.

To understand the conditions described above it may be helpful to give a brief account of the present-day conception of the normal process of intestinal rotation in the embryo and of the irregularities which may occur in this process. In 1916, FRAZER and ROBBINS (3) published a

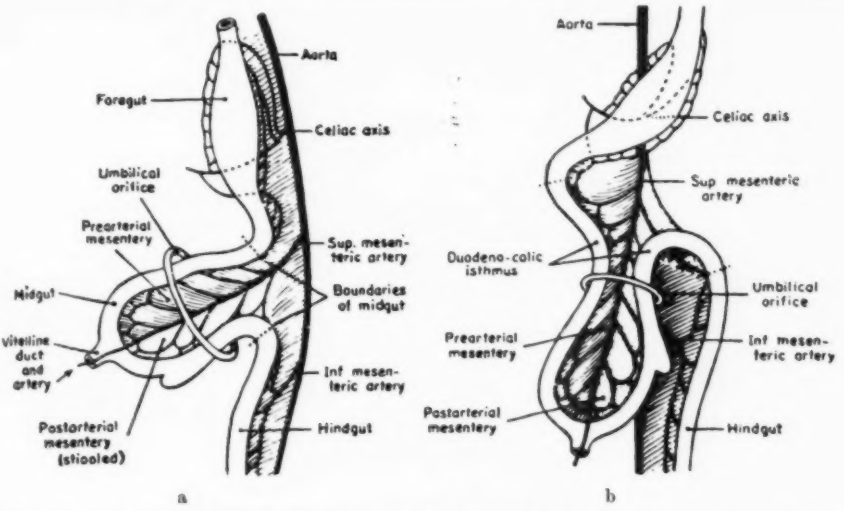

Fig. 2. First stage of intestinal rotation. a. Seen from the side before rotation. Broken lines indicate the segment of the gut participating in the rotation. b. End of first stage, seen from front after 90 degrees counter-clockwise rotation of midgut loop (after GARDNER).

very thorough study on the normal conditions, which forms the basis for many subsequent descriptions of malrotation in the surgical literature. DOTT (2) is mentioned as the first who applied this knowledge to practical surgery, but the study published by LADD (5) in the thirties is better known. A very lucid description of the conditions in pathologic cases was given by GARDNER, Jr. (4), in 1950. This description forms the basis of the following account.

The midgut (from the duodenojejunal junction to the mid-transverse colon) participates in the rotation. The rotation of the midgut loop is divided into three stages. Before the rotation begins the growth of the liver forces the midgut into the umbilical cord, where it lies as a herniation. The rotation begins in the eighth week of intra-uterine life, the first stage being a counter-clockwise rotation of 90 degrees (Fig. 2 a and b). If developments fail to proceed beyond this stage, the infant presents an omphalocele at birth. This may be either complete or partial. We have recently seen a case in this hospital in which 20 cm of the small intestine was retained in the umbilical cord of the infant.

In the second stage, the midgut loop returns to the peritoneal cavity. This stage is assumed to occur very quickly, as the process of return or its various phases have never been observed. The segment of the small intestine is thought to be reduced first as the caecum, when the intestine has returned to the abdomen, lies above the loops of the small intestine just below the liver. While the intestine returns to the abdomen, the rotation continues in a counter-clockwise direction, so that the small intestine passes under the superior mesenteric artery and further to the left side of the abdomen, thus undergoing

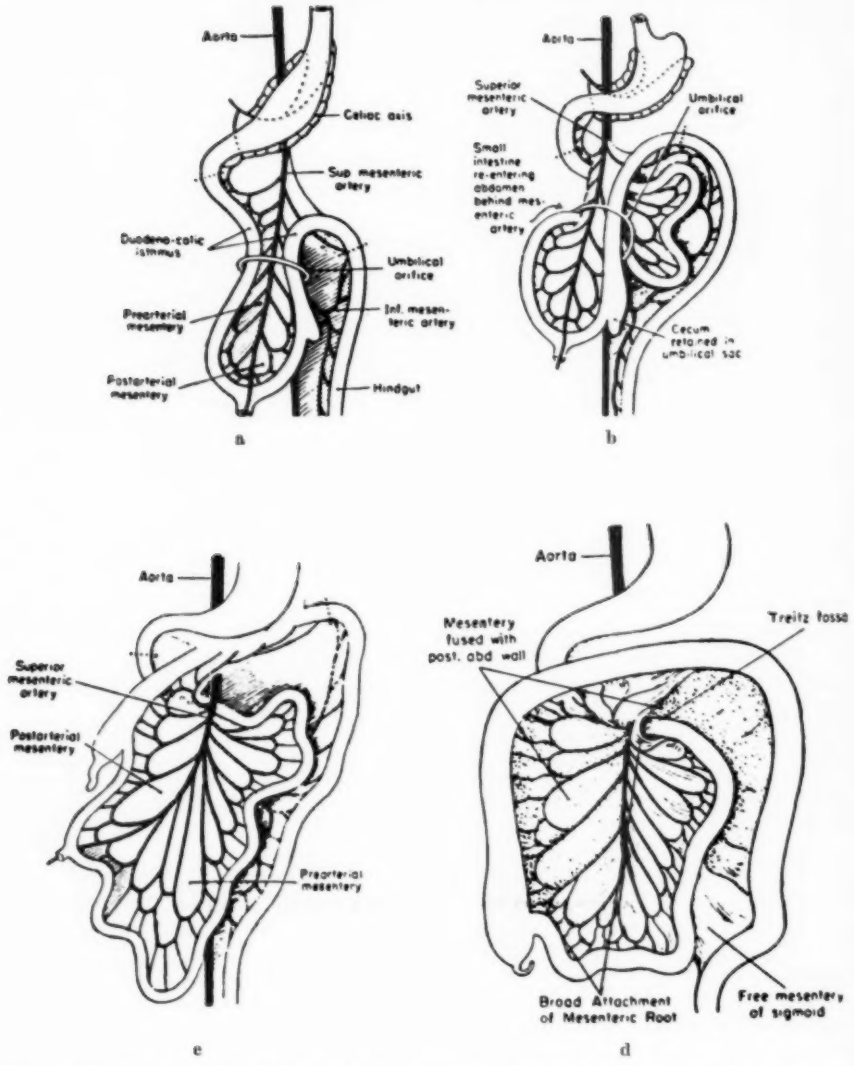

Fig. 3. Second and third stage of intestinal rotation. a. At. the beginning. b. Midgut in the process of passing behind superior mesenteric artery. c. End of second stage. d. End of third stage. Caecum in normal position with fixation of mesentery. (after GARDNER).

a rotation of 180 degrees. The small intestine is then fixed by its mesentery. The second stage of the rotation occurs in the tenth week of intra-uterine life (Fig 3, a, b and c).

The most important anomalies occur in the second stage.

If rotation fails to occur, the condition is termed non-rotation. The duodenum lies on the right of the superior mesenteric artery; the small intestine is on the right side of the abdomen and the caecum on the left. The ascending colon passes up to a point between the duodenojejunal flexure and the greater curvature of the stomach, while the transverse colon forms a small U-shaped loop. Non-rotation may not give rise to any symptoms, but it is of surgical significance in the presence of diseases of the appendix or caecum. Both in non-rotation and in normal rotation, fixation of the small intestine over a wide base of the mesentery may fail to occur, which predisposes to volvulus.

Innumerable irregular defects in intestinal rotation and fixation are possible during the second stage; these are grouped together under the term malrotation. Defects of the mesentery may occur if a loop of the small intestine is trapped under the mesenteric root. Other abnormalities of intestinal fixation may give rise to kinks or compression of the lumen of the intestinal tract at any level, but especially in the duodenum. In certain cases the caecum may be firmly fixed to the duodenum or small intestine, thus causing compression of the lumen. Intraperitoneal bands and adhesions which occur regularly with anomalies of intestinal rotation may be present in various combinations and may cause obstruction. Many investigators are inclined to believe that most internal herniae are referable to malrotation.

Reversed rotation is a rare anomaly in which the intestinal rotation occurs clockwise, so that the duodenum comes to lie in front of the superior mesenteric artery and the transverse colon under it.

The third stage of the rotation comprises the formation and final fixation of the entire mesentery; simultaneously the caecum passes downwards and to the right to its normal place, and fixation of the ascending colon occurs (Fig. 3 d).

Anomalies of the third stage include subhepatic caecum, retrocaecal appendix, and mobile caecum. These conditions are *per se* of little clinical importance, but they may predispose to volvulus of the caecum and should be kept in mind when a diagnosis of appendicitis is to be considered.

It is understandable, and reasonable to assume, that arteriomesenteric occlusion in older children and adults with a normal position of the abdominal viscera may be due to mild malrotation in which the rotation as such has occurred in a normal way, but in which fixation anomalies have arisen; experience shows that such anomalies are often localized in the vicinity of the duodenum. Operative findings provide strong evidence in support of this view. In addition, in two patients with unquestionable malrotation (subhepatic caecum) we have roentgenologically demonstrated arteriomesenteric obstruction with dilatation, reversed peristalsis and stasis of the duodenum. Adhesions and abnormal bands between the caecum and duodenum were absent in these cases.

As already mentioned, the cause of obstruction may be of an 'intrinsic' nature. During the formation of the small intestine in foetal life, an intestinal lumen is present up to the fifth week. This lumen is later closed and subsequently re-formed by a vacuolization process. If a defect occurs during this re-formation, atresia of the small intestine develops, which, if complete, gives rise to total intestinal occlusion immediately after birth. However, in certain cases the atresia is incom-

plete. There is then a septum in the intestine, but the septum has an opening of a varying diameter, through which some passage of the intestinal contents is possible. This incomplete atresia gives rise to severe symptoms in early childhood. In 11 cases of duodenal obstruction, LADD (5) found an intrinsic cause in five and an extrinsic cause in six. In a search of the literature, I have been unable to trace any cases of congenital intrinsic obstruction in children over 5 years of age, and in our own cases no such obstructions have been present. The characteristic features in our cases are the relatively late occurrence of the disease, the uniform roentgenographic appearance and the presence of nervous or neurotic symptoms in a considerable proportion of the cases.

As far as children are concerned, WINKEL SMITH has emphasized these features and recalled that in many children with actual malrotation the correct nature of the symptoms is not recognized, and the treatment given is therefore often wrong.

It is important to realize that intestinal obstruction due to malrotation because of irregular fixation may occur both in older children and in adults, even though an abnormal position of the abdominal viscera cannot be demonstrated.

All authors concur that there are two groups of patients with arteriomesenteric obstruction. The first group consists of patients with congenital disorders, whereas in the second group the condition is acquired. It is difficult, if not impossible, to draw a clear line of distinction between the two groups, even if we accept malrotation as the cause of congenital obstructions. Certain patients will be encountered who cannot be definitely classified within either of these groups.

Case 3. A woman, aged 32, was admitted to this hospital and subjected to operation in March 1941.

In 1938, intense pain had suddenly developed in the right side of the abdomen, radiating to the homolateral shoulder. As the pain persisted, the patient was subjected to appendectomy elsewhere, but no improvement occurred. In 1939, the patient was admitted to another hospital, where pancreatitis was suspected. Roentgen examination in our hospital revealed obstruction at the level of the duodenojejunal junction with reversed peristalsis and duodenal dilatation (Fig. 1 C). At operation, an adhesion between the gall-bladder and the duodenum and a strong fibrous band in the omental bursa from the posterior aspect of the stomach right across to the duodenum and down to its underside were disclosed. The band was divided, and the resultant opening in the mesocolon sutured. It was stated in the case record that the band may very well have occluded the duodenum. The patient recovered completely, and at a follow-up examination in the Department of Radiology in November 1955 there was no occlusion at the duodenojejunal junction and no signs of reversed peristalsis.

Whether the fibrous band dated back to the appendectomy in 1938 or was referable to malrotation is difficult to say with certainty, but the complete absence of relief after the appendectomy is in favour of the latter assumption.

Acquired duodenal stenosis may be due to a variety of different causes, such as duodenal ulcer, periduodenitis, pericholecystitis, perforating biliary calculi, carcinoma of the papilla of Vater or of the pancreas, retroperitoneal tumours, and other lesions. Through the years I have encountered numerous cases in which the roentgenograms have shown dilatation and stasis of the duodenum down to the duodenojejunal flexure and co-existing duodenal ulcer. One patient who had been subjected to simple suture of a perforated duodenal ulcer was admitted for renewed operation. This patient died in the hospital, and both the second operation and subsequent autopsy revealed periduodenal adhesions, which had presumably given rise to the roentgenographic appearance. A distinct reversed peristalsis had been noted. However, the explanation of the roentgen findings is scarcely so simple in all cases with duodenal ulcer. Dilatation and stasis of the duodenum may be seen both in this disease and in other disorders, but reversed peristalsis is often absent, especially in pancreatitis, where the movements of the barium mixture may be very sluggish.

No matter how the relationship between duodenal ulcer and dilatation, stasis and, perhaps, reversed peristalsis of the duodenum, is to be explained, it is of importance to know these conditions, because the possibility of duodenal ulcer or other demonstrable causes must be ruled out with the greatest possible degree of certainty when a diagnosis of arteriomesenteric obstruction is considered. The differentiation is facilitated to some extent by the fact that the duodenal bulb is slightly dilated in arteriomesenteric obstruction; it therefore fills readily and rapidly and appears to be normal. On the other hand, this phenomenon may sometimes have diverted the attention of the radiologist from the conditions in the distal part of the duodenum and made him conclude the examination too early.

A diagnosis of arteriomesenteric obstruction should be made only after repeated demonstration of reversed peristalsis and the other pathologic conditions in the duodenum described above. In young children, in whom the pathologic roentgen findings are often due to 'intrinsic' causes, the causative factors cannot be diagnosed with certainty. LADD emphasized that in such patients it is impossible to say beforehand what the operation will disclose.

The aforementioned conditions with chronic intermittent arteriomesenteric occlusion will thus be more frequent in older children and adults, and I believe that in these patients the predominant causative factor will prove to be anomalies of fixation due to irregularities in the normal intestinal rotation, even though the abdominal viscera are in their normal place.

The following table gives a survey of our cases.

Table

Series of patients	M.	F.	Total
Arteriomesenteric obstruction, operated on	2	3	5
Do., with caecal displacement do.	2	2	4
Fibrous band? malrotation? operated on		1	1
Arteriomesenteric obstruction, not operated on	2	4	6
Total	6	10	16
Age of patients, in years			
5—20	2	5	7
21—30	1	2	3
Over 30	3	3	6
Total	6	10	16

As far as possible, the treatment should consist in conservative medical measures with bed rest, and small meals. If this treatment proves unsuccessful, recourse to operation may be necessary, which in such cases should be duodenojejunostomy.

SUMMARY

The importance of roentgenographic demonstration of dilatation, reversed peristalsis, and stasis of the duodenum, in adolescents and adults is considered. The author concludes that mild malrotation is present in many cases in which the abdominal viscera are normally situated, and that the obstruction at the duodenojejunal flexure is due to abnormal fixation and adhesions referable to defects in intestinal rotation. Other causes of the syndrome, including, in particular, duodenal ulcer, are discussed.

ZUSAMMENFASSUNG

Die Bedeutung des röntgenologischen Nachweises der Dilatation, der Gegenperistaltik und der Stauung des Duodenums bei Jüngeren und Erwachsenen wird erwogen. Der Verfasser konkludiert, dass in vielen Fällen, bei denen die Bauchorgane normal gelagert sind, eine leichte Malrotation vorhanden ist, und dass die Obstruktion in der Flexura duodeno-jejunalis auf abnormer Fixierung und auf Verwachsungen beruht, die auf Fehlhaftigkeiten der intestinalen Rotation zurückzuführen sind. Andere Ursachen dieses Syndromes, besonders die Rolle des Duodenalgeschwüres, werden diskutiert.

RÉSUMÉ

L'auteur examine l'importance de la mise en évidence par la radiographie de la dilatation, de l'anti-péristaltisme et de la stase du duodénum chez les adolescents et chez les adultes. Il conclut que, dans de nombreux cas où les viscères abdominaux sont en situation normale, il existe un léger défaut de rotation et que l'obstruction à l'angle duodéno-jéjunal est due à une fixation anormale et à des adhérences en rapport avec des défauts de rotation intestinale. L'auteur étudie d'autres causes de ce syndrome, y compris, en particulier, l'ulcère duodénal.

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BLOOD PRESSURE AND HEART RATE DURING ANGIOCARDIOGRAPHY, ABDOMINAL AORTOGRAPHY, AND ARTERIOGRAPHY OF THE LOWER EXTREMITIES

by

A. K. Amundsen, P. Amundsen and *O. Müller*

Previous investigation by MALUF & MCCOY (1955) and DOTTER & STEINBERG (1951) have shown that a constant fall in peripheral arterial pressure occurs immediately after the injection of contrast media during angiocardiography and aortography. As far as we are aware, no information, however, exists concerning the duration of the interval between the injection and the fall in blood pressure in these two procedures.

Methods and material. The blood pressure in the aorta was measured at frequent intervals in patients during angiocardiography, aortography, and peripheral arteriography. When aortography or angiocardiography was performed a separate catheter was inserted into the abdominal or thoracic aorta for blood pressure measurements. During peripheral arteriography the contrast medium was injected through catheters inserted into both internal iliac arteries, the pressure recording apparatus being connected to one of the two catheters by means of a 3-way stopcock. The pressure recording had therefore to be interrupted during the injection. The pressure-sensitive apparatus was of a strain-gauge type (Elema) and the pressure trace recorded on an Elmqvist Triplex electrocardiograph together with an ECG and a 'seriogram'.

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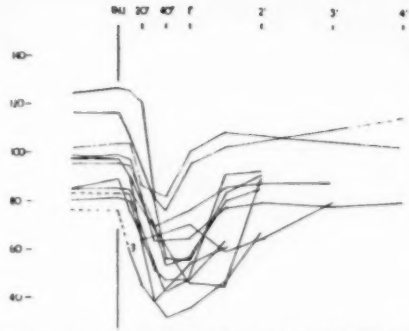

Diagram 1. Angiocardiography. Peripheral mean blood pressure before, during and after injection.

Diagram 2. Aortography. Peripheral mean blood pressure before, during and after injection.

During aortography and angiocardiography the pressures were usually recorded continuously from shortly before the injection to 30 seconds following it. Thereafter short strips were recorded at short intervals. Nycotrast (diodone) 70 % was used in most instances, but was replaced by a 50 % preparation in some of the peripheral arteriographies.

For the injection the Gidlund pressure syringe was used, as a rule with a pressure of 3 Atms. Angiocardiography was carried out under narcosis induced by Citopan together with succinylcholineiodide and artificial ventilation. When more than one injection was carried out in peripheral arteriography, the second and third injections were also made under narcosis. Angiocardiography was performed in 16 instances in 9 different patients with localized pulmonary disease or funnel chest. None of the patients had signs of right—left or left—right cardiac shunts or prolonged circulation time. Ten (10) patients were investigated with 12 aortographies. Nine (9) had renal or adrenal disease. Nine (9) arteriographies were carried out in 7 patients with peripheral vascular disease. In 4 cases ordinary saline was injected in connection with aortographies. This was done to clarify the effect of inert solutions injected with our technique. When two or more injections were carried out, the intervals between them were 15 to 20 minutes.

Results. During angiocardiography no major blood pressure reaction or consistent alterations in heart rate was observed during the injection, nor immediately following it (Diagram 1). Ten (10) seconds after the injection the findings somewhat varied, in most instances the blood pressure remaining constant or showing an insignificant fall or rise. In 4 investigations, however, there was a fall in aortic blood pressure of 8 mm Hg or more. Twenty (20) seconds after injection all readings

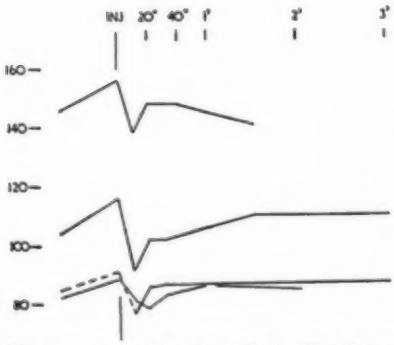

Diagram 3. 'Aortography'. Peripheral mean blood pressure before, during and after injection of saline.

showed a definite decrease in pressure, with an average fall of 16 mm Hg, varying, however, from 4 to 20 mm. The fall continued for 30 and 40 seconds after the injection with a mean of 30 and 40 mm Hg respectively. One minute after the end of the injection, however, the pressure again started to rise in all cases.

The heart rate was surprisingly unaffected in most cases, with a small decrease in rate within 10 seconds after the injection followed by a slight tachycardia shortly afterwards. Three (3) cases, however, displayed a marked bradycardia 10 to 20 seconds after the injection and one case developed a sino-auricular block or sinus arrest with ventricular standstill of 10 seconds' duration, commencing 10 seconds after the injection.

In 10 of the 11 aortographies a definite, but slight, increase in blood pressure during the injection occurred, followed by a marked fall within 10 seconds (Diagram 2). The fall in pressure developed rapidly with a mean fall of 30 (17 to 43) mm Hg 20 seconds after the injection and reached its maximal mean fall of 39 mm Hg 40 seconds following it. One minute after the injection all but one of the pressures had started to rise again; only 1 out of 6, however, had reached its pre-injection level 4 minutes after the injection. During the injection there was a slight slowing of the heart rate in 9 out of 11 cases. As the pressure fell, the heart rate increased, and decreased again as the blood pressure was restored, thus behaving in an opposite fashion to the aortic blood pressure.

As previously mentioned recordings were carried out during and after the injection of saline in 4 cases (Diagram 3). Pressure and heart rate reaction during the injection and for the first 10 seconds after it, were very similar both in direction and magnitude to those recorded in ordinary aortographies. Twenty (20) seconds after the injection, however, the effect had almost completely disappeared.

The reaction to peripheral arteriography was very similar to that in the aortographies, but showed smaller deviations from the pre-injection values. Twenty (20) seconds after the injection the average pressure fall was 16 mm Hg and a further 20 seconds later reached 28 mm Hg. The alterations in heart rate were less obvious except in one case with marked brachycardia and in one which developed an atrio-ventricular block 3 to 4 seconds after the injection.

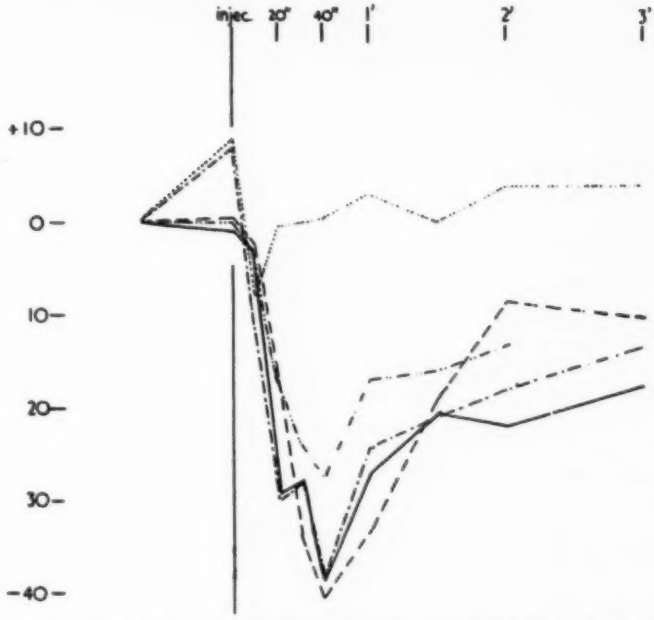

Diagram 4. Average peripheral mean blood pressure reaction during and after injection. (Scale in mm Hg.)

Discussion

Our observations seem to show that the fall in blood pressure develops more rapidly in aortographies than in angiocardiographies. Twenty (20) seconds after injection the mean B. P. fall was 30 and 16 mm Hg respectively (Diagram 4). Statistic variance analysis shows this difference to be significant with P less than 0.01. As the mean maximal fall is the same, *i. e.* 39 and 40 mm Hg, respectively, we find it reasonable to conclude that the main pressure fall occurs significantly earlier in the aortographies than in the angiocardiographies. In the latter the contrast medium reaches the central organs (heart, coronary circulation, brain) earlier than in the former. The contrast medium, Nycotrast, employed seems therefore to possess a definite peripheral vasodilating effect. The blood pressure curves recorded during the pressure fall appear to support this view. They are characterised by high-pointed peaks early in systole with a markedly lower bulge late in systole, low incisura, and a relatively flat diastolic portion, a curve-form which WIGGERS (1952) described as typical for low resistance in the aortic area (Diagram 5)

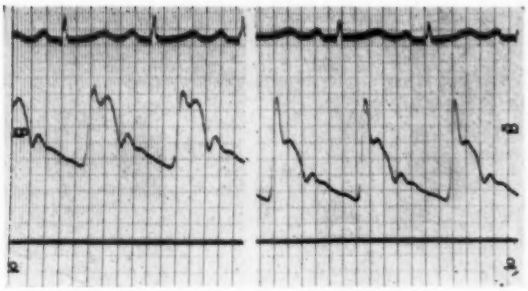

Diagram 5. Angiography. Blood pressure recordings before injection (mean blood pressure about 100 mm Hg) and during pressure drop. (Mean blood pressure about 70 mm Hg.)

Maluf and McCoy (1955) found the effect on the blood pressure to vary with different types of contrast medium. The greatest hypotensive effect was observed with Neo-Iopax, less with Diodrast, and was barely perceptible with Urokon. We intend to continue our investigations with a view to ascertaining the effect of different contrast substances.

In aortographies and angiocardiographies similar blood pressure reactions were accompanied by different heart rate responses (Diagram 6).

The blood pressure and the heart rate reactions in the former were very well accounted for by the ordinary aortic-carotid sinus reflexes. The angiocardiographies, however, showed a simultaneous fall in blood pressure and heart rate as an initial reaction to the injection. The Bainbridge reflex, an increase in right auricular pressure during the injection, should lead to an increase in heart rate, where in our investigations a decrease was actually observed. Some mechanism other than the aortic-carotid sinus or Bainbridge reflexes therefore seems to be involved; the cause of the fall in heart rate is probably a result of strong vagal stimulation arising from the heart or lungs or a direct effect of the contrast medium on the heart muscle which also may account for the different types of heart block.

Disturbances of the heart rhythm in the form of bradycardia and blocks were frequent in angiocardiographies. Repeated injections in the same patient are especially apt to produce these disturbances and are therefore best avoided; if necessary, the patient ought to be controlled with continuous ECG and B. P. measurements. These latter proved to be of special value in a patient with phaeochromocytoma who was submitted to aortography; in this case the hypotensive effect was followed by a hypertensive attack.

As previously mentioned some of the investigations were carried out with the patient in narcosis; Citopan and succinylcholine iodide were employed. Immediately after the injection of the former there was, in most cases, a fall in blood pressure. In 5 out of 11 cases this fall continued for more than 2 to 5 minutes although the pressure usually reached

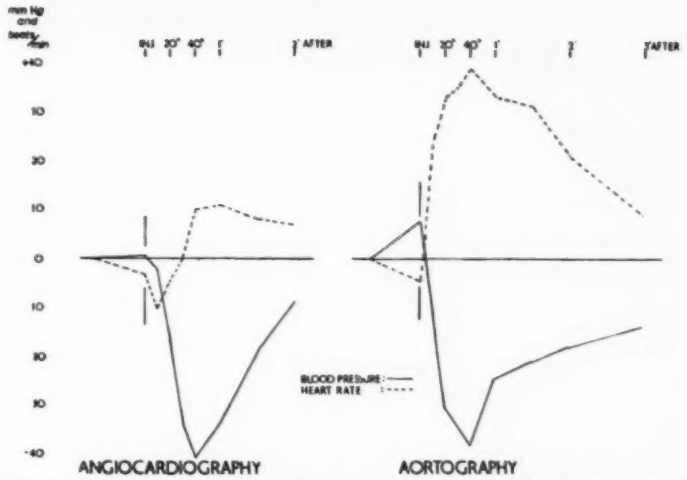

Diagram 6. Average heart rate and peripheral mean blood pressure reaction in angiocardiography and aortography.

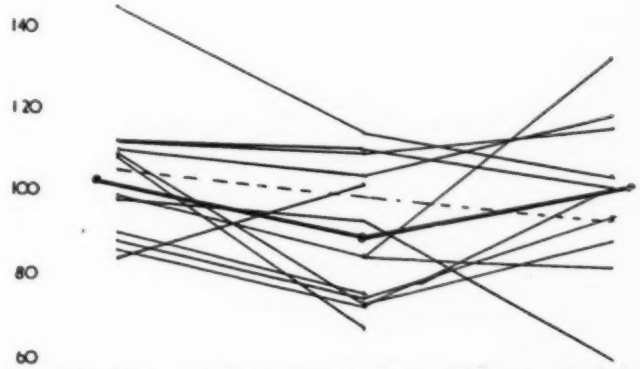

Diagram 7. Mean blood pressure before, shortly after, and 2 to 5 mins after, induction of narcosis.

its previous level during this time (Diagram 7). We therefore find it reasonable to postpone the investigation until the risk of additive hypotensive effects has passed.

SUMMARY

The blood pressure dropped earlier during aortography than during angiocardiography, indicating a peripheral vasodilation effect of the contrast medium. During the

former the heart rate varied as if dependent on the aortic-carotid sinus reflexes; during the latter, however, the early slowing of the heart rate was probably the result of vagal stimulation originating in the lungs or heart, or the action of the contrast medium directly on the heart muscle.

ZUSAMMENFASSUNG

Bei der Aortographie fiel der Blutdruck frühzeitiger als bei der Angiokardiographie, welches auf einen peripheren vasodilatatorischen Effekt des Kontrastmittels hinweist. Während der Aortographie schwankte die Herzschlagfrequenz, im gleichen Sinne wie beim Sinus aortae — Carotissinusreflex; während der Angiokardiographie jedoch war die frühzeitige Abnahme der Herzschlagfrequenz wahrscheinlich das Ergebnis einer vom Herzen oder von den Lungen ausgehenden Vagusstimulierung oder der Einwirkung des Kontrastmittels direkt auf den Herzmuskel.

RÉSUMÉ

La pression sanguine s'abaisse plus tôt au cours de l'aortographie qu'au cours de l'angiocardiographie, indiquant un effet vaso-dilatateur périphérique du moyen de contraste. Au cours de l'aortographie le rythme cardiaque a varié comme s'il dépendait de réflexes des sinus aortique et carotidien; au cours de l'angiocardiographie, par contre, le ralentissement précoce du rythme cardiaque était probablement dû à une stimulation vagale partie des poumons ou du cœur, ou à l'action directe du moyen de contraste sur le muscle cardiaque.

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ROENTGENOLOGIC FINDINGS IN THE STOMACH AND DUODENUM IN CANCER OF THE PANCREAS

by

Kaare A. Larsen and *Arne Pedersen*

The diagnosis of cancer of the pancreas has always been difficult, often being made only at autopsy. It is a common experience to find on post-mortem examination an advanced malignant tumour in the pancreas in cases in which clinical and roentgenologic examinations failed to establish such a diagnosis.

Because of the clinical symptoms, especially pain and dyspepsia common in this condition, the patient will at some stage often be referred for roentgen examination of the stomach and duodenum. This investigation essentially consists in registering changes in the stomach and, possibly of greater interest, alterations in the duodenal loop. Barium contrast examinations have not always given the desired results, and other methods have therefore been tried. ORDNOFF and SANTE introduced the pneumoperitoneum. ENGEL and LYSHOLM used gas insufflation of the stomach, the subsequent roentgenography being carried out with various projections.

Until recently the barium contrast examination of the stomach and duodenum has proved the most important roentgenologic means of determining expansive processes in the pancreas. Following the development of new and improved techniques with shorter exposure times and varying positions, details of the stomach and duodenal loop have become demonstrable to a much greater extent. A number of works of recent years have given more detailed roentgenologic findings in malignant processes of the pancreas (RIGLER 1933, PAUL 1936, FROSTBERG 1938 and CASE 1940). In a Caldwell Lecture, CASE discussed the different diseases

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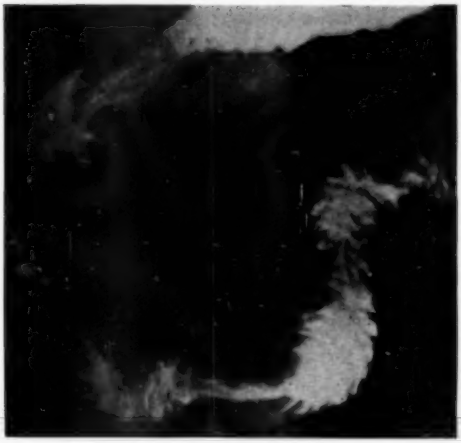

Fig. 1

Fig. 2

Fig. 1. Cancer of the head of pancreas. Markedly widened duodenal loop, and small impressions on medial side of duodenum.

Fig. 2. Cancer of head and body of pancreas. Somewhat widened duodenal loop. Minor defects in upper part of duodenum, partly on outer aspect due to liver hilus gland metastases.

in the pancreas from a roentgenologic point of view, and his work has become fundamental in the field.

Further works on the subject have appeared (BROADBENT and KERMAN 1951, POPPEL 1951 and 1953, and BEELER and KIRKLIN 1952). Poppel's first work, 'Roentgen Manifestations of Pancreatic Disease', is comprehensive and discusses all pancreatic conditions capable of producing roentgenologic changes. In his second publication, in co-operation with JACOBSEN and SMITH: 'The Roentgen Aspects of the Papilla and Ampulla of Vater', tumours of the head of the pancreas are discussed. The latest work in this field is by HODES, PENDERGRASS and WINSTON. It describes retrospective examinations made of patients who have had malignant disease of the pancreas, the lower choledochus, or Vater's papilla. Their examinations have shown that in about fifty per cent of the cases the tumour could not have been found in the routine barium contrast examination of the stomach and duodenum. BEELER and KIRKLIN have arrived at similar results. They emphasized that a tumour in the head of the pancreas with infiltration of the duodenum may present roentgenologic signs of a duodenal ulcer, and that this may delay the correct diagnosis. Another interesting fact was that relatively small tumours gave positive roentgen findings nearly as often as did larger inoperable ones.

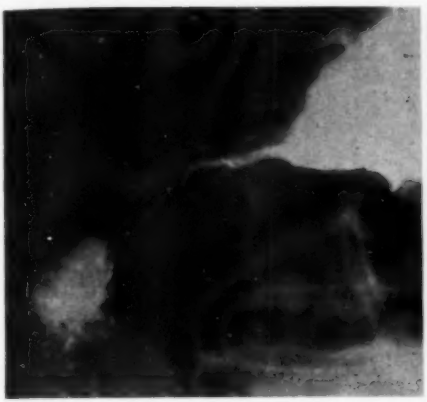

Fig. 3. Cancer of head and body of pancreas. Constriction of pyloric antrum and upper part of duodenum. Rigid, narrow duodenum with irregular mucous membrane relief.

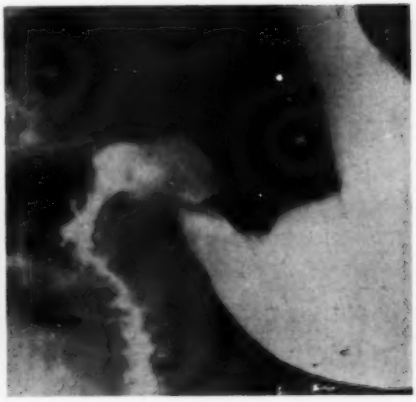

Fig. 4. Cancer of head and body of pancreas. Displacement of second part of duodenum. Impression on duodenal bulb due to tumour infiltration in hilus hepatis.

Purely from a treatment point of view, radical surgical intervention will probably be of value, if performed at an early stage. PUESTOW, WURTS and OLANDER analyzed 37 cases of carcinoma of the ampulla of Vater to evaluate methods of diagnosis and treatment. They found roentgen studies helpful when showing positive findings. In 39 cases, there were positive findings in 10 cases, and 29 cases were negative. In 6 of the last group benign ulcers were found in the duodenal bulb. The positive findings were as follows: Ulcer in descending duodenum 1; widened duodenal loop 4; widened duodenal loop with duodenal diverticulum 2; widened duodenal loop with enlarged ampulla of Vater 1; pyloric obstruction 1, and extrinsic pressure on the duodenum 1. They found the results of surgical treatment to be bad, and improvement necessary both in palliative bile-shunting operations and radical procedures.

Other authors have reported similar results, *i. e.* STAFFORD, RIDGEWAY TRIMBLE and CLASSEN, MC. DERMOTT JR. and BARTLETT. LEACH has drawn attention to an interesting point. He believes he has shown that carcinoma of the body or tail of the pancreas forms metastases more often and more widely than the carcinoma of the head of the pancreas. This may be due to the fact that tumours in the body and tail are discovered later than in the head. In any case, his postulate ought to stimulate further concentration on tumours in the head of the pancreas, where the diagnostic and therapeutic possibilities are better.

Fig. 5. Cancer of head of pancreas. Large defects in pyloric antrum, duodenal bulb, and second part of duodenum. Displacement of last part of the duodenal loop.

Fig. 6. Cancer of head of pancreas. Irregular defects in last part of duodenum with constrictions. Dilatation and displacement of upper part of duodenum.

It is known that quite a number of the pancreatic tumours produce comparatively early symptoms, particularly by effects upon the biliary ducts. The chances of finding a non-metastasizing tumour of a malignant nature in the head of the pancreas are not so slight, in view of the diagnosis. MIKAL found 20 patients without metastases in 100 cases of confirmed carcinoma of the pancreas and with improved diagnoses the number would probably increase. When performing barium meal examinations of the stomach and duodenum, the more common conditions such as cancer of the stomach or gastric or duodenal ulcer, come readily to the mind. Cancer of the pancreas is perhaps rarely considered if not suggested by definite clinical symptoms. The frequency of cancer of the pancreas has, however, increased to such an extent that diagnostically it must be taken into account far more often than has previously been the case. In 1,701 autopsy materials (average age 66 years) from the Ullevaal and Aker Hospitals for 1954, 79 showed cancer of the stomach and 38 cancer of the pancreas. The latter is thus not an uncommon condition, and because of the symptomatology such cases may be referred at a comparatively early stage to the roentgenologist. An examination of the loop and lumen of the duodenum may give an important clue to an early diagnosis.

Contemporary research on the new contrast media for the biliary ducts also suggest possibilities for diagnosis, especially of tumours in the head of the pancreas.

Fig. 7

Fig. 8

Fig. 7. Cancer of head of pancreas. Small defects and minor irregular constriction in last part of duodenum. Pad sign in the pyloric antrum.

Fig. 8. Cancer of head and body of pancreas. Irregular rigid relief and small defects in last part of duodenum. Dilatation of the upper duodenum. Impression and suggested pad sign in pyloric antrum.

The authors have examined a small autopsy series from Aker Hospital for a 5-year period, and have studied all patients with the diagnosis of cancer of the pancreas, a total of 50 cases. Of these patients, 31 had a barium meal examination of the stomach and duodenum in the course of the disease. All roentgenograms of these patients were reviewed and, in 18, signs were found which possibly indicated a malignant condition in the pancreas. In 13 cases there were no indications of such disease. Of the 18 cases with positive findings it appeared that changes had been reported and the diagnosis made, or rendered probable, in 8. In 10 cases there were negative findings or other diagnoses, *e. g.* coarse mucous membrane folds in the stomach and duodenum, ulcer deformity of the duodenal bulb, ulcer of the stomach. The findings mostly overlooked were small impressions in the duodenal bulb and loop, situated near the head of pancreas and lying generally posteriorly in the duodenum. For the rest, minor displacements of the duodenal loop were overlooked, as also were less marked constrictions and rigid contours.

It appears that of the present material of 50 cases, about one third might have shown positive signs of cancer of the pancreas. Of the 31 examined roentgenologically in the course of the disease, there was in more than half the cases some positive findings that should have suggested the diagnosis. With a thorough examination and attention directed particularly to the possibility of cancer of the pancreas, it may be presumed

that positive clues to the diagnosis would have been found in more than half, possibly in nearly two thirds of the cases. With the development of the short exposure high-voltage technique, a clear reproduction of the mucous membrane relief in the stomach, and especially in the duodenal loop, should bring us closer to such a result.

The present material has been studied with a view to the positive changes found in the roentgenograms, and these have been correlated to the pathologic-anatomic descriptions. In such retrospective examination where there has been no opportunity of recording such changes in function which are observable on fluoroscopy and palpation, alterations in the roentgenograms have been the only source of information. The following findings which, in the authors' opinion, have contributed to the diagnosis of cancer of the pancreas, have been registered:

1) Small, comparatively smooth impressions and defects (mucous membrane probably intact):
   A) Bulb and upper duodenum (*i. e.* deformed duodenal bulb) 12
   B) Lower duodenum 3
2) Defects with highly irregular mucous membrane relief (probably infiltration of mucous membrane) in body and lumen of stomach and duodenum 8
3) Widened duodenal loop 6
4) Displacement of the stomach and duodenum 6
5) Constrictions and dilatations in duodenum 4
6) Retractions with changes in mucous membrane relief 4
7) Post-bulbar impressions in duodenum 4
8) Pad sign A) in pyloric antrum 2
   B) in duodenal bulb 2
9) Calcifications in tumour 1

It appears from the survey that the comparatively small impressions and defects represent the most constant findings and through a more advanced technique would no doubt be demonstrated much more often than in the present material. The upper part of duodenum and the parts around the papilla of Vater are the particular sites of these changes. In the lower part of duodenum they are less frequent. The position of the pancreas in, and partly posterior to, the duodenal loop makes even small expansive processes capable of causing impressions in an otherwise normal mucous membrane relief. Roentgenograms obtained in several oblique positions are most desirable in these cases.

Major defects, displacements, and a widened duodenal loop are of course good indications. These are, however, comparatively late signs and mainly indicate wide extension of the tumour, often retroperitoneally.

Fig. 9

Fig. 10

Fig. 9. Cancer of head and body of pancreas. Impressions upward on duodenal bulb due to tumour infiltration in hilus hepatis. Niche-shaped bulging and mucous membrane convergence due to tumour infiltration with shrinking of the gastro-hepatic ligament.

Fig. 10. Cancer of head and body of pancreas. Irregular defects and rigid contours in duodenum. Mucous membrane convergence due to tumour infiltration with shrinking.

Changes in the distance between the duodenum and the spinal column are an unreliable sign, several interpretations such as fat infiltration, ascites, cysts, anomalies, and inflammatory conditions, being possible. A considerable increase in the distance indicates the possible presence of massive retroperitoneal infiltration. In the relatively confined malignant processes in the pancreas the increase in the distance is inconstant.

The retractions with changes in the mucous membrane of the stomach or duodenum observed in the material were found to be the result of tumour infiltration in the walls themselves, with no extensive infiltration of the mucous membrane. In one case there was tumour infiltration of the gastro-hepatic ligament which caused shrinking and a convergent retraction of the lesser curvature with a niche-like bulging. The so-called post-bulbar impression in two cases proved to be due to dilatation of the gall-bladder and in two to glandular metastases in the hilus hepatis. In no case was a marked dilatation of choledochus believed to be the cause of the impression. Comparatively few cases showed the pad sign. The reason may possibly have been the use of an inadequate compression technique. In two cases the pad sign was observed in the duodenal bulb. There was tumour infiltration extending back of the duodenal bulb

which, on slight compression, had appeared as defects of a somewhat irregular nature, but nevertheless should have been distinguishable from cicatricial changes following a duodenal ulcer. In carrying out examinations with a special view to changes in the head of the pancreas a greater number of defects than those found in the present material would probably be revealed by means of adequate compression.

With regard to the patho-anatomic changes of diagnostic importance detectable in the barium contrast examination of the stomach and duodenum, it is obvious that the location of the malignant tumour is of foremost importance. Changes in the head and, to some extent, the body of the pancreas render signs much earlier than do changes in the tail and the pyloric antrum. The duodenal bulb and, to some degree, the duodenal loop are especially affected. In order to obtain a survey of the findings and the roentgenologic changes, the material was placed into the following groups, according to the growth and distribution of the tumour.

1) *Small tumours in the head or body of the pancreas.* Small impressions in the duodenum. Compression of the choledochus and dilatation of the biliary ducts may give post-bulbar impressions.

2) *Larger tumours in the head or body of the pancreas.* Large impressions and displacements of duodenum. Constrictions, pad sign.

3) *Tumour infiltration beyond the pancreas* (in wall and lumen of duodenum). Rigid, irregular mucous membrane relief, irregular defects. Star-shaped retractions due to shrinking. Ulcerations.

4) *Metastases to the glands.* Impressions in duodenum, especially on medial aspect of duodenal loop. With glandular metastases in the hilus hepatis, bulbar impressions may be present.

5) *Large, irregular, retroperitoneal infiltrations and infiltration of the gastro-hepatic ligament.* Major defects and displacements. Increase of the distance between the spinal column and the duodenal loop. Irregular retractions in the stomach and duodenum by shrinking. Constrictions.

The diagnoses based on such findings are evidently not pathognomonic of cancer of the pancreas. All expansive processes in the pancreas are capable of producing similar changes, and this naturally complicates the diagnosis. However, a correlation of the findings and the clinical symptoms will be of great help in making the final decision.

The differential diagnostic possibilities are as follows.

Duodenal ulcer and cicatricial changes. Bulbar and post-bulbar changes in cancer of the pancreas may imitate an ulcer-deformed duodenal bulb. This has been one of the most important erroneous diagnoses. Fluoroscopy and serial films will be decisive. However, the danger will, in most cases, consist in overlooking the fact that the changes may be due to tumour infiltration of the pancreas.

Fig. 11

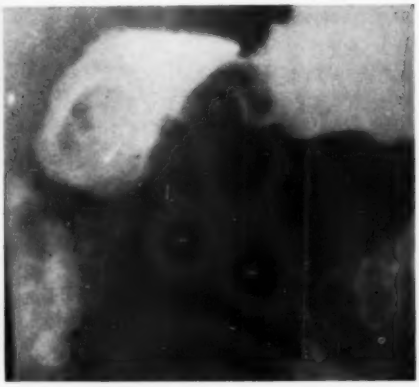

Fig. 12

Fig. 11. Cancer of head and body of pancreas. Rigid contours and irregular defects in duodenal bulb and upper part of duodenal loop.

Fig. 12. Cancer of head of pancreas. Deformed duodenal bulb with small defect.

Cancer-metastases in the hilus hepatis and retroperitoneally. Here the displacements usually embrace larger parts of the duodenal loop, and are often found on the lateral aspect of the loop, or possibly somewhat posteriorly. A differential diagnosis is often impossible.

Chronic pancreatitis and fibrosis of the pancreas. There may be impressions similar to those seen in tumour infiltration; these are comparatively smooth without signs of infiltration of the mucous membrane.

Acute pancreatitis (occlusion of the pancreatic duct and haemorrhagic pancreatitis). In these cases the clinical picture with the roentgenologic findings will give the correct diagnosis.

Pancreatic cyst. The isolated, smoothly rounded impressions may give a very important clue to the diagnosis.

Tumour of the papilla of Vater. The localized defect with evidence of occlusion of the choledochus will be significant. The tumours mostly give comparatively extensive defect in the papilla Vateri region with a somewhat irregular mucous membrane relief and no signs of displacements or other changes in the duodenum or its lumen.

Cancer of the duodenum. Changes in the mucous membrane relief with smaller or larger defects are the most conspicuous features. Changes such as displacements and retroperitoneal infiltrations are comparatively rare.

There are also a number of other differential diagnoses that should be mentioned, *e. g.* duodenal diverticula, aberrant pancreatic tissue, regional

glandular conditions, retroperitoneal tumours, and inflammatory conditions.

In most cases the diagnosis of cancer of the pancreas will be a probable one when a number of symptoms and objective findings must be correlated. With the more recent methods for examination of the biliary ducts, the diagnostics of diseases in this difficult region has made some progress. Still better results may be obtained by using retroperitoneal air insufflation and transverse tomography. For early diagnosis and complete evaluation of malignant disease of the pancreas, however, examination of the stomach and duodenum will always be of essential importance, especially when proper techniques are employed.

SUMMARY

The authors have made a retrospective examination of a small autopsy series for a 5 year period. A total of 50 cases of cancer of the pancreas was found, 31 of which had had a barium contrast examination of the stomach and duodenum; eighteen (18) of the cases showed positive signs for which the malignant condition in the pancreas might have been responsible. It is concluded that the roentgenologic findings in the stomach and duodenum may be characteristic and give a clue to the diagnosis at an early stage.

ZUSAMMENFASSUNG

Die Verfasser haben eine kleine Sektionsserie einer Fünf-Jahresperiode nachuntersucht. Insgesamt fanden sie 50 Fälle mit Pankreaskarzinom; bei 31 dieser Fälle war eine Kontrastuntersuchung des Ventrikels und des Duodenums ausgeführt worden und 18 von den 31 Fällen zeigten positive Befunde, für welche der maligne Prozess im Pankreas verantwortlich gewesen sein könnte. Es wird gefolgert, dass die röntgenologischen Befunde im Ventrikel-Duodenum charakteristisch sein können und einen Leitfaden für die Stellung der Diagnose im Frühstadium geben kènnen.

RÉSUMÉ

Les auteurs ont examiné rétrospectivement une petite série d'autopsies portant sur une période de 5 ans. Ils ont rassemblé un total de 50 cas de cancer du pancréas, dont 31 avaient subi un examen par contraste baryté de l'estomac et du duodénum; dix-huit (18) de ces cas présentaient des signes positifs dont le cancer du pancréas pourrait avoir été la cause. Ils concluent que les signes radiologiques gastriques et duodénaux peuvent être caractéristiques et donner la clef du diagnostic à un stade précoce.

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FROM THE ROENTGENDIAGNOSTIC DEPARTMENT (PROF. KNUT LINDBLOM),
KAROLINSKA SJUKHUSET, STOCKHOLM, SWEDEN

A COMPRESSOR FOR USE IN FOETAL ROENTGENOGRAPHY

by

Paul Edholm

As the scope of foetal roentgenography increases the need for improvement in film detail becomes more apparent. The compressor shown in Fig. 1 has been found useful in improving the quality of roentgenograms of the foetus taken with the mother lying on her side and the beam in a vertical direction. It consists of two plates and two rods made of plastic, and a notched metal bar; the two plates are joined by the two rods, the upper plate being hinged on the latter.

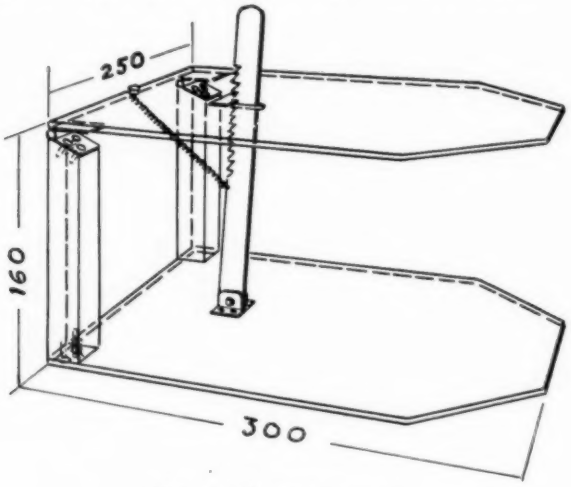

Fig. 1. The compressor.

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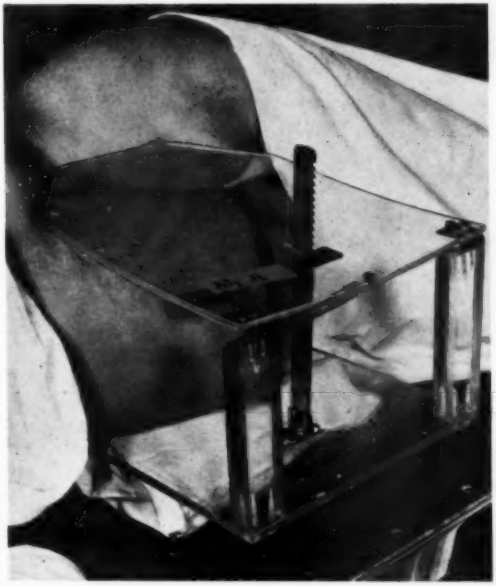

Fig. 2. Application of compressor.

Compression is achieved in the following way: a small cushion is placed under the lower plate. The patient is instructed to lie on her side with the abdomen resting on this plate and to breath in and then out. While she is breathing out the abdomen is compressed by lowering the upper plate to the desired level and hooking it into the correct notch in the iron bar (Fig. 2).

Even slight compression has proved to reduce the depth of tissues to be penetrated thus permitting the employment of decreased kilovoltage and exposure time. The films obtained show good contrast and fine detail. The method has also proved useful in restraining the movements of the foetus and in bringing the foetal extremities slightly parallel to the film. As ossification centres in the knee-joints show up well it also enables more accurate determination of foetal maturity. Another advantage of the method is that the presence of gas in the circulatory system of the foetus is easily identified, especially if the films are taken with the mother lying on her back and the beam in a horizontal direction.

The method has so far been used in about 100 cases. In no case did it cause discomfort to the mother or injury to the foetus.

Fig. 3. Roentgenogram taken in lateral projection with compression.

SUMMARY

A compressor, which has proved useful in foetal roentgenography, is described.

ZUSAMMENFASSUNG

Eine Kompressionsanordnung, die sich bei der Röntgenuntersuchung des Fötus als wertvoll erwiesen hat, wird beschrieben.

RÉSUMÉ

Description d'un compresseur qui s'est montré utile pour la radiographie foetale.

FROM THE ROENTGENDIAGNOSTIC DEPARTMENT (DIRECTOR: PROF. OLLE OLSSON), UNIVERSITY HOSPITAL, LUND, SWEDEN

A SIMPLE INSTRUMENT FOR URETHROCYSTOGRAPHY AND FISTULOGRAPHY IN ADULTS AND CHILDREN

by

Åke Gullmo

The fundamental work of KNUTSSON and EDLING and the instrument devised by KNUTSSON paved the way for wider use of urethrocystography and fistulography. KNUTSSON's instrument cannot, however, always be used in the examination of children should synechia between the prepuce and the glans penis prevent application of the clamp, or the urethral orifice not be large enough to permit satisfactory introduction of the terminal cone to prevent leakage. Hypospadias and other anatomic anomalies also prevent the use of the appliance. EDLING (1945) reported that KNUTSSON's device could not be used in 2 out of 3 cases of mild hypospadias.

CHEVASSU (1933) described a device consisting of a short rubber sound that was passed into the urethra and held in position by a small pneumatic ring around the penis. However, such a ring will hardly prevent extrusion of the sound on application of an injection pressure necessary for the proper examination of the posterior urethra.

KJELLMAN (1952) devised an appliance originally intended for the examination of females. The tip of the injection cone is held in the urethral orifice by means of a rubber sucker around the cone. This method, especially the application of the sucker, is, however, time-consuming, besides which it cannot be used in the examination of patients with hypospadias or anatomic anomalies.

STÄHLI (1955) described a method according to which a Guyon catheter with a terminal onion-shaped cone is passed into the urethra, where it is held in position by a penis clamp. In some respects this method

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Fig. 1. Record syringe needles with terminal cones, 2.5 to 10 mm in diameter.

resembles the one described below, although the instruments are completely different.

Since 1953 we have used an instrumentarium (Fig. 1) consisting of a set of ordinary record syringe cannulae, 1 to 1.2 mm in diameter and 8 to 10 cm in length, and provided with a terminal cone ranging in diameter from 2.5 to 11 mm.

Technique. The entire set of cannulae is sterilized before the examination. After inspection of the urethral orifice a cannula of suitable size is selected; if it passes readily, the next size is tried, and so on until the cannula fits firmly in the external os, which is the narrowest part of the urethra. In addition the orificial tissue does not yield so readily as that of the rest of the urethra and therefore often grips the cannula tightly behind the posterior part of the cone and holds the cannula in position. Should the cannula tend to slip out, it may be fixed by means of a con-

stricting rubber band or gauze bandage; when the cone is withdrawn against the tightening band it acts as a valve and seals the orifice.

A rubber or plastic tube about half a metre long with a Record syringe fastened at one end permits the injection of the contrast medium from behind the screen protecting the examiner's hands against radiation during fluoroscopy. The inner diameter of the tube should be 2.5 mm in order to fit the Record syringe and permit rapid exchange of the syringe for re-filling.

Fig. 2. Boy, aged 8 years. Stenosis ('medium bar') in upper part of posterior urethra. Valvular formation in lower part of posterior urethra.

The tube is filled with contrast medium before it is connected to the cannula. In order to be sure that no air bubbles have entered the urethra, a small amount of contrast medium is alternately injected and aspirated, the tube, the cannula, and the anterior urethra, being held vertical. The pars anterior and the pars bulbosa urethrae usually hold 10 to 15 ml of fluid. After this amount has been injected, a roentgenogram is made of the anterior urethra. During the injection of a further 15 ml of contrast medium roentgenograms are taken of the posterior urethra. Repeated doses are injected for further exposures in accordance with the technique described by KNUTSSON, EDLING, MORALES & ROMANUS.

After sufficient roentgenograms have been taken the examination is continued during urination, preferably with the patient lying, because fixation is better in this than in the standing position. Urination is performed through the instrument. The first exposure is made when the flow is seen to be strong enough. It is usually possible to take 3 roentgenograms during urination. In the examination of small children urination can often be induced by tickling them around the umbilicus.

Some children may be very nervous during the examination and the sphincter may be closed so tightly that ordinary injection pressure is not enough to force the contrast medium through the prostatic urethra. No attempts should be made to increase the pressure; the patient is,

Fig. 3. Hypospadia glandis. The cone self-retained in the meatus.

Fig. 4. Man, aged 19. Hypospadia glandis. The cone self-retained in the external os. Large concrement in urethra.

Fig. 5. Man, aged 77. Prostatic hyperthrophy. Phimosis. The cone is fixed with band around prepuce over the sulcus coronarius.

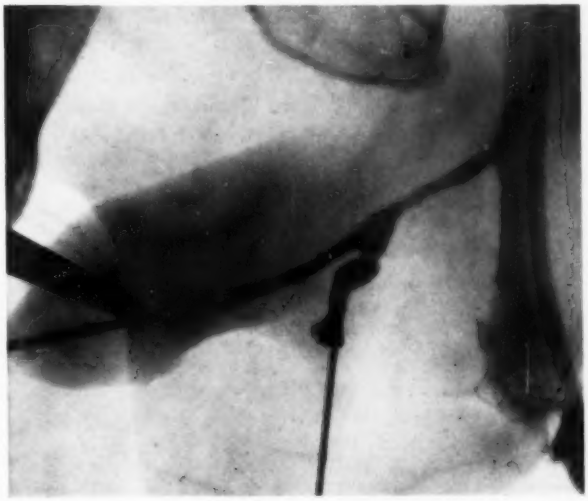

Fig. 6. Combined urethrography and fistulography. Rubber drain in prostatic abscess.

however, instructed to pass water and the attempt to do so will usually reduce the resistance offered to the passage of contrast medium, which can then be injected under moderate pressure. The injection of the contrast medium often gives the patient the feeling that he is passing water; in such cases a so-called medium bar with or without hypertrophy of the trigonum is often found. A case of this type is shown in Fig. 2; there was also a valvular formation at the typical site in the lower part of the prostatic urethra (JORUP & KJELLBERG). We have often found such a narrowing of the bladder neck in boys with diurnal enuresis. Such stenosis probably increases the tonus of the bladder musculature with consequent enuresis. Diurnal enuresis therefore always indicates urethrocystography.

The instrument described has been found especially useful in the examination of patients with hypospadias and other anatomic anomalies. In such cases the urethral orifice is usually so small that the largest possible cannula of the series set fits firmly without additional fixing (Figs. 3 and 4).

As a rule KNUTSSON's appliance cannot be used in the presence of phimosis. However, with the aid of a rubber band tied around the prepuce over the sulcus coronarius, the examination may be performed without difficulty (Fig. 5).

The cannulae may also be used for other purposes such as fistulography (Fig. 6). As a rule the external opening of a fistula is small and the marginal tissue fibrous, this facilitating firm anchorage of the instrument.

The cannulae can be readily manufactured by instrument makers of Record syringe needles. They are also available from G. Crona, Instrument maker, Lasarettet, Lund, Sweden.

SUMMARY

A simple appliance for urethrocystography and fistulography in adults and children is described.

ZUSAMMENFASSUNG

Ein einfaches Hilfsmittel für die Ausführung der Urethrocystographie und der Fistulographie bei Erwachsenen sowie bei Kindern wird beschrieben.

RÉSUMÉ

Description d'un instrument simple pour l'urétrocystographie et la fistulographie chez l'adulte et chez l'enfant.

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FROM THE ROENTGENDIAGNOSTIC DEPARTMENT (DIRECTOR: PROF. K. LINDBLOM), KAROLINSKA SJUKHUSET, STOCKHOLM, SWEDEN

SOME PRACTICAL AIDS IN ROUTINE WORK

by

Ove Mattsson

A safer telescopic centering device

The centering guide mostly used in the Scandinavian countries is a telescopic rod, sometimes with a screw or bayonet mount, attached to the frame for the plate diaphragms. A certain type of telescopic device has also been used in conjunction with cones (WATSON 1942).

The telescopic centering device is very useful, but has certain distinct disadvantages which were mentioned earlier by the present author (1953) in discussing a new centering device with a light beam. It is, however, not always possible to use optical or other centering devices without a sharp-pointed rod with which there is a possible danger of injury to patient and operator, especially in rooms darkened for screening. The face and eyes may be said to be particularly exposed to this danger.

To reduce the effects of involuntary contact with the sharp pointer, the author has made its extremity soft and flexible. The distal part of the pointer consists of a helical spring, and the tip has a soft rubber cover. The helical spring is soldered to the stiff tubular part (a cross section of it is shown in Fig. 1). The spring may enclose a plastic rod which smooths out its action. Fig. 2 shows the arrangement.

An aid in screening work

When screening patients, the indication of the location of an anatomic detail on the skin is not infrequently of value. By using protective rubber gloves when performing palpation, this may easily be done by hand. Very

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Fig. 1

Fig. 2

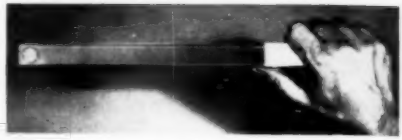

Fig. 3

Fig. 1. Cross-section of flexible point of telescopic centering device.

Fig. 2. The flexibility of the pointer protects patient and operator against injuries.

Fig. 3. Slat with lead indicator.

often, however, it is desirable to make landmarks without allowing the hands to enter the beam of radiation. This is especially important when patients who have been screened prone or supine with an under-couch tube are to be roentgenographed with another tube vertically from above. It is then necessary to indicate the center of the proposed field if accurate centering of the latter tube is to be obtained.

A small lead disc, attached to a thin slat of transparent acrylic material (plexiglass, perspex), may be moved in the film area and avoids interception of the beam of radiation by the hands. It is easy to observe fluoroscopically and necessary adjustments and centering operations may be carried out with its help. This simple arrangement, for which no originality is claimed has proved to be of practical value especially in gastro-intestinal examinations in the horizontal position. The slat with the lead indicator is shown in Fig. 3.

A timer for urography

All urographic examinations require some sort of timing, *i. e.* the respective roentgenograms must be taken in a definite order with certain fixed intervals. For that purpose arrangements have been proposed to simplify the marking of films with time values of 5, 15 minutes, etc. I would refer to the urographic "clock' by WILLNER (1953) with small metal indices and a time table which are depicted roentgenographically

Fig. 4

Fig. 4. Timer for urography or other examinations with special time table.

Fig. 5. Various accessories attached to magnifying viewer.

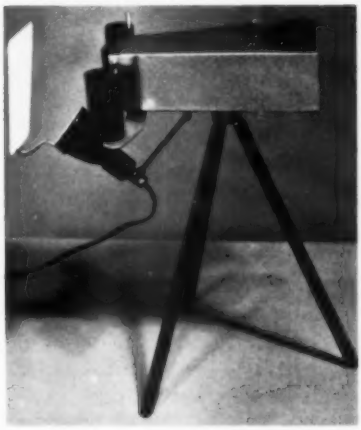

Fig. 5

on the film simultaneously with the main exposure. DENNIS (1944) described a rotating indicator with pointers attached to a plate simulating a clock face; with the indicator adjusted to the injection time, the suitable points of time for exposures were easily determined.

A timer especially suited for urographic examinations has been developed. It consists of an inverted ordinary timer of the type used for cooking, laboratory work, etc., and with a special dial having reversed figures. When the injection of contrast medium is performed, the timer is started from zero, no mathematical calculations being necessary to arrive at the correct time. When two examinations are being carried out simultaneously, each urographic table may have its own timer and no mistakes regarding the time will be possible.

The time table has a set of figures especially suited for urography. Five and fifteen minutes are indicated as the two time constants when roentgenograms will be taken. The minute division of the dial can be easily read. A special 15-minute division makes the timer useful in connection with cholegraphic examinations, in which films are ordinarily taken at 15-minute intervals. At 60 minutes there will be a signal, when, if necessary, the timer may be re-started.

The appearance of the timer is shown in Fig. 4. The index moves anticlockwise, but the timer is wound up by turning it clockwise to zero. The apparatus has functioned well and makes correct timing much simpler, particularly in urographic and cholegraphic examinations; it is also useful for other medical purposes.

Some accessories to the magnifying viewer

The viewer for films described by the author in this publication in 1953 was devised for examining detail of all ordinary roentgen films as well as for photofluorographic film. To simplify viewing when mass chest films in uncut rolls are to be studied, a special holder, which may be attached to the viewer by means of a simple mount, has been developed. This fixture, which carries the rolls, may be mounted vertically or horizontally.

In order to facilitate the study of films still further and to free both hands, a 'camera' screw is mounted so that the viewer can be attached to an ordinary photographic tripod. The arrangement may be supplemented by a small integral source of light especially adapted for the study of mass chest radiographs. A small bulb in a special shade is supplemented by a white screen and produces homogeneous illumination on a field of suitable size for the study of photofluorographic films. The details described, which naturally may be used independently, have been combined in the photograph shown in Fig. 5. (These, as well as the viewer, were manufactured by AB Georg Schönander.)

SUMMARY

A number of devices designed to facilitate roentgenologic work are described. They consist of a centering guide with a soft flexible tip, a lead indicator for simplifying centering, and a timer for urographic and other examinations. The magnifying viewer, previously described by the author, has been supplemented by a number of accessories.

ZUSAMMENFASSUNG

Eine Reihe von Anordnungen zur Erleichterung der Röntgenarbeit werden beschrieben. Sie bestehen aus einer Richtanordnung mit weicher beugbarer Spitze, einem Bleiindikator zur Vereinfachung der Zentrierung und einem Zeitnehmer für Urographien und andere Untersuchungen. Der vom Verfasser kürzlich beschriebene Bildbetrachtungsapparat ist durch eine Anzahl von Zusätzen vervollständigt worden.

RÉSUMÉ

L'auteur décrit quelques accessoires destinés à faciliter le travail radiologique. Ce sont un centreur à extrémité souple et flexible, un indicateur en plomb pour simplifier le centrage et un marqueur de temps pour les urographies et autres examens. Le négatoscope précédemment décrit par l'auteur a été complété par quelques accessoires.

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AUS DEM RADIUMHEMMET (CHEFARZT: PROF. SVEN HULTBERG) UND DEM RADIOPATHOLOGISCHEN INSTITUT, KAROLINSKA SJUKHUSET (DIREKTOR: PROF. LARS SANTESSON), STOCKHOLM, SCHWEDEN

DIE BEHANDLUNG MALIGNER TESTISTUMOREN AM RADIUMHEMMET, STOCKHOLM

Bericht über 247 Patienten

von

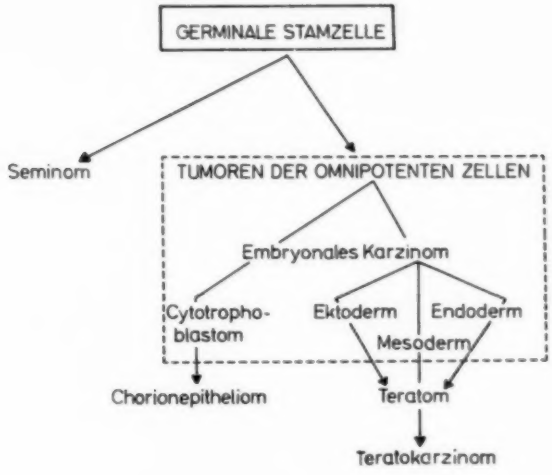
Gustaf Notter

Die bösartigen Testistumoren sind für den Strahlentherapeuten ein dankbares Gebiet, da sie zum grossen Teil strahlensensibel sind. Ihre Neigung zur schnellen Metastasierung und eine Tumormortalität von 30 bis zu 100 % in den verschiedenen Gruppen (Tab. 2) sprechen aber gleichzeitig für ihren hochmalignen Charakter. Bei der der Ablatio testis folgenden Strahlentherapie ergeben sich wegen der ausgedehnten regionären Lymphabflussgebiete eine Reihe von Problemen, deren Besprechung an Hand der bisher behandelten Patienten Zweck dieser Untersuchung ist.

Pathogenese und Einteilung

Embryologie und Pathogenese dieser Tumoren waren lange unklar. Grundlegende Arbeiten wurden von CHEVASSU (11), EWING (17), TEILUM (49, 50) u. a. geleistet. Auf die Bedeutung der Choriongonadotropinausscheidung wiesen FERGUSON (18), BANG, HAMBURGER u. NIELSEN (4), BÉCLÈRE, GIBERT u. HINGLAIS (6) hin. Über die bisher grösste Patientengruppe von 920 resp. 990 Fällen berichteten 1946 FRIEDMANN u. MOORE (20) und 1952 DIXON u. MOORE (16). Sie bedienten sich einer modifizierten Einteilung nach EWING und TEILUM, die sowohl pathogenetischen wie auch klinischen Besonderheiten Rechnung trägt. Sie unterscheiden: germinale und vom Stützgewebe ausgehende Tumoren. Die Erstgenannten gehen aus den germinativen Zellen hervor und umfassen 96 % aller Testistumoren. MOORE gibt folgendes Schema über Abstammung und Entwicklung dieser Tumoren an.

Bei der Redaktion am 17. Februar 1956 eingegangen.



Zur germinalen Gruppe gehören:

1. Seminome: uniforme, grosszellige, von den Spermatogonien abgeleitete Tumoren.
2. Embryonale Karzinome: unreife, wenig differenzierte, anaplastische Karzinome oder Sarkome, evtl. mit Seminomanteilen.
3. Reife Teratome: reifere Tumoren mit erkennbarer Differenzierung von verschiedenen Keimblättern.
4. Teratokarzinome: eine Mischgruppe mit teratoiden und wechselnden Anteilen der anderen Gruppen.
5. Chorionepitheliome: hervorgegangen aus Cytotrophoblasten oder syncytialen Trophoblasten.

Zu den 4 % von Stützgeweben ausgehenden Tumoren zählen Zwischenzelltumoren, Androblastome, Fibrome, Angiome, Neurofibrome und adenomatöse Tumoren des Rete.

Ätiologie. Dem *Trauma* wird heute nach den Untersuchungen von Wesson sowie Gilbert u. Hamilton (22) keine ätiologische Bedeutung mehr zuerkannt, trotzdem in 20 % aller Fälle anamnestisch ein deutliches Trauma vorliegt. Es zeigte sich nämlich, dass die Tumorchance beim abdominellen Kryptorchismus mit 1 : 20 4mal grösser ist als beim traumatisch stärker exponierten inguinalen Kryptorchismus (9, 16, 21).

Der *Kryptorchismus* wurde lange als prädisponierende Ursache für die Tumorentstehung angesehen. Nach Kocher, Hofstätter sowie Winterstein (54) entstehen in ungefähr 5 %, nach Gilbert u. Hamilton (22) in 11 % der Kryptorchiden Testistumoren, was ungefähr 8—15 % aller malignen Testistumoren entspricht (9, 22). In descendierten Hoden entstehen diese dagegen nur in 0.0013 %. Bei einseitigem Kryptorchismus entsteht in 96.8 % der Tumor im retinierten Testis, bei bilateralem Kryptorchismus in 24.6 % in beiden Testes. Dies scheint für eine direkte Beziehung von Kryptorchismus und Tumorätiologie zu sprechen. Caroll u. Grove (23) bezweifeln doch die Gültigkeit dieser Angaben, da die wirkliche Anzahl aller ektopischen und retinierten Testes post partum nicht sicher bekannt sei. In grösseren Statistiken schwankt sie von $^1/_2$ bis 5 %. Damit ändert sich auch die davon abhängige Tumorfrequenz. Weitere Fehler sind möglich durch

klinische Fehldiagnosen gewisser Retentions- und Pseudoretentions-Formen, auf die Browne (7) mehrfach hingewiesen hat.

Dass Kryptorchismus und Atrophie eine kausale Rolle bei der Tumorentwicklung spielen, ist unwahrscheinlich, möglicherweise sind aber deren Ursachen von ätiologischer Bedeutung (22).

Die in retinierten Testes vorhandene Atrophie und funktionelle Minderwertigkeit manifestiert sich gegenüber descendierten Hoden, entgegen älteren Auffassungen, bereits nach dem 5. Lebensjahre. Dies wurde von Robinson u. Engle (46) bei einseitigen Kryptorchiden durch Biopsie-Serien an beiden Hoden nachgewiesen. Hieraus erklären sich vielleicht die übereinstimmend schlechten funktionellen Resultate (Atrophie, Aspermie, Androgenmangel) nach Orchipexie (23, 10, 2), wenn diese wie früher erst während oder nach der Pubertät vorgenommen wurde. Daher strebt man heute die Frühoperation vor dem 6. Lebensjahre (23, 26, 46) oder bereits in den ersten Säuglingsmonaten an (49). Ob die Resultate damit besser werden, bleibt abzuwarten.

Ob man mit der Orchipexie eine Tumorprophylaxe betreiben kann, müssen erst die Resultate der Frühoperation in 10—20 Jahren zeigen. Die bisherigen Beobachtungen nach der Spätoperation sprechen nicht dafür. Raines u. Hurdle (44) sahen bei einem 51 jähr. Pat. mit praepubertalem Kryptorchismus trotz späteren spontanen Descensus eine Tumorbildung. Sie glauben, dass es hierbei immer zur Bildung von Seminomen kommen müsse. Dies ist jedoch falsch. Kaplan u. Roswit sahen 27 Jahre nach einer doppelseitigen Orchipexie im 14. Lebensjahre die Bildung eines Seminoms im rechten Hoden und 4 Jahre später ein Teratokarzinom im linken Hoden. Gordon-Taylor u. Wyndmann sahen 6 ähnliche Fälle, Chevassu u. Carillan 5, Graf 1, Rusche 4 und Grove 3 Fälle (54, 48, 23).

In diesem Zusammenhang interessiert auch die Hormontherapie beim Kryptorchismus.

Seit 1930 werden nach dem Beispiel von Schapiro hypophysäres und plazentares Gonadotropin zur Einleitung des Descensus verwandt. Die Meinungen über den endgültigen Wert dieser Behandlung sind nach anfänglicher Begeisterung heute sehr geteilt. Die Erfolgsmeldungen schwanken zwischen 90 % (51) und 0 % (40). Browne (7) glaubt, dass es sich bei den Erfolgen nur um Pseudoretentionen handele, die sowieso spontan descendieren, während echte Retentionen nicht reagieren. Einseitige Retentionen sprechen nicht auf Hormonbehandlung an, doppelseitige am besten im Alter von 5—7 Jahren. Mit einer Dosierung 250 IE 3 × wöchentlich während 1—2 Monaten vermeidet man Pubertas praecox und aus dem gleichen Grunde soll auch Testosteron vermieden werden (15). Auch in Verbindung mit der Operation können Hormone angewandt werden, da sie neben einer Stimulierung der Testes auch Fett, Muskelgewebe und Gefässe vermehren und so das Skrotum für die Aufnahme des Testis vorbereiten.

Auf ein gestörtes Hormongleichgewicht deutet auch die *Gynäkomastie*, die sonst nur bei Jugendlichen in der Pubertät, älteren Männern oder nach Östrogentherapie beobachtet wird. Bei den Testistumoren tritt sie meistens einseitig 2—6 Monate nach Beginn der Behandlung auf. Sie überwiegt in der Karzinomgruppe. In einzelnen Fällen besteht sie schon bei Beginn der Behandlung.

Auch die Selbstheilung primärer oder metastatischer Chorionepitheliome beruht wahrscheinlich auf hormonellen Faktoren oder der Bildung von einem antisyncytialen Antikörper, dem Cytolysin, das im Blute von Schwangeren vorkommt, bisher aber beim Chorionepitheliom noch nicht nachgewiesen werden konnte (33). Richter erzielte die Heilung einer Chorionepitheliom-Kranken durch Transfusion von Schwangerenblut, was jedoch von anderen Autoren später nicht mehr wiederholt werden konnte. Vereinzelte therapeutische Erfolge wurden auch nach Stilböstrol und Entfernung des anderen Hoden gesehen.

So spielen für die Ätiologie der Testistumoren hormonelle Einflüsse zweifellos eine wichtige Rolle. Daneben ist eine angeborene Differenzierungsschwäche germinaler Zellkomplexe denkbar.

Eigene Untersuchungen

Ahlbom (1) berichtete 1947 über 119 maligne Testistumoren, die 1921—41 im Radiumhemmet behandelt wurden. Da seine Einteilung den heutigen Erkenntnissen nicht mehr ganz gerecht wird, wurden diese 119 Fälle nachträglich nach Moore klassifiziert und mit in das Material einbezogen.

Insgesamt wurden 250 Tumoren bei 247 Patienten behandelt, davon 33 Patienten in den Jahren 1951—54. Für diese kann daher keine 5-Jahresheilung berechnet werden. Da die Tumorsterblichkeit bei den Testistumoren aber schon nach dem 1. Jahre stark nachlässt und nach dem 3.—4. Jahre praktisch ganz vernachlässigt werden kann, wird über diese Fälle mitberichtet. Sie werden aber in Tabelle 3 gesondert aufgeführt. Alle Tumoren sind histologisch untersucht.

Das Durchschnittsalter der Seminome liegt mit 40.8 Jahren (21—80) etwas höher als das der übrigen Tumoren 34.0 (0.5—77). Dies wird auch von anderen Untersuchern bestätigt.

Zwischen links- und rechtsseitigen Tumoren bestand in unseren Fällen zahlenmässig kein signifikativer Unterschied. Die Anzahl der Patienten und deren Verteilung auf die einzelnen Tumorgruppen sind aus der Tabelle 1 ersichtlich.

Tabelle 1

Anzahl der Patienten und Tumorfrequenz bei den 214 von 1921—50 behandelten Patienten, verglichen mit Dixon *u.* Moore *und* Raines *u.* Hurdle

	Eigenes Material		nach Dixon und Moore	nach Raines und Hurdle
Seminome	107 Pat.	= 50.0 %	34.0 %	48 %
Embryonale Karzinome	39 »	= 18.2 %	22.5 %	32 %
Teratome (reife)	8 »	= 3.8 %	10.2 %	18 %
Teratokarzinome	59 »	= 27.6 %	31.1 %	
Chorionepitheliome	0 »	= 0 %	2.1 %	0 %
Nicht-germinale Tumoren				
Mesonephric-Carcinoma	1 »	= 0.4 %		

Tabelle 2 gibt eine Übersicht über die Metastasenfrequenz zu Beginn der Behandlung und über das 5-Jahresbehandlungsresultat in den einzelnen Gruppen und die entsprechenden Zahlen von Dixon u. Moore.

Die Wichtigkeit der Frühdiagnose und schnellen Behandlung wird besonders bei den Seminomen klar. Bei Fällen *ohne* klinisch manifeste Metastasen erreichten wir eine 5-Jahresheilung von 87.5 % bei denen *mit* manifesten Metastasen nur 18.5 %. Hierbei ist zu berücksichtigen,

Tabelle 2

Anzahl der Patienten, Metastasenfrequenz und 5-Jahresbehandlungsresultat in den einzelnen Tumorgruppen verglichen mit den Ergebnissen von DIXON *und* MOORE

	Anzahl Pat.		nach 5 Jahren leben symptomfrei	leben mit Met.	tot
Seminome					
mit Met.	27 = 25.3 %	(11 %)	5 = 18.5 %	1	21 = 77.8 %
ohne Met.	80 = 74.7 %		70 = 87.5 %	—	10 = 12.5 %
Sämtliche	*107*		*75 = 70.1 %*	(89.5 %)	*31 = 28.9 %*
Embryonale Karzinome					
mit Met.	20 = 51.3 %	(33 %)	2 = 10.0 %	—	18 = 90.0 %
ohne Met.	19 = 48.7 %		3 = 16.5 %	1	15 = 79.0 %
Sämtliche	*39*		*5 = 12.8 %*	(35.5 %)	*33 = 84.6 %*
Teratome					
mit Met.	2 = 25.0 %	(24 %)	—	—	2
ohne Met.	6 = 75.0 %		4	1	1
Sämtliche	*8*		*4 = 50 %*	(71.0 %)	*3*
Teratokarzinome					
mit Met.	24 = 40.6 %	(20 %)	3 = 12.5 %	—	21 = 87.2 %
ohne Met.	35 = 59.4 %		21 = 60.0 %	—	14 = 40.0 %
Sämtliche	*59*		*24 = 42.8 %*	(48.0 %)	*35 = 57.2 %*
Nicht-germinale Tumoren			—		—
mit Met.	1		—	1	—
	214		108 = 50.5 %	4=1.8 %	102 = 47.7 %

Die in Klammern aufgeführten Zahlen sind die entsprechenden Vergleichzahlen nach DIXON und MOORE.

dass die erste Gruppe wahrscheinlich eine grosse Anzahl von mikroskopischen oder durch Palpation nicht festzustellenden klinischen Metastasen enthielt. Das magere Behandlungsergebnis bei den embryonalen Karzinomen und Chorionepitheliomen beruht weniger auf deren Strahlenresistenz als frühzeitigen hämatogenen Streuung. Die Ablatio testis und Röntgenbehandlung der manifesten Metastasen ist daher in diesen Fällen unzureichend und der Exitus erfolgt meistens innerhalb weniger Monate.

Beim Teratokarzinom sind die Behandlungsergebnisse etwas besser. Reine Chorionepitheliome kamen bei unseren Patienten nicht vor. Bei DIXON u. MOORE (16) betrugen diese 2.1 % des Gesamtmaterials.

Die guten Ergebnisse dieser Untersucher beruhen nach deren eigener

Tabelle 3

Anzahl der Patienten und Tumorfrequenz bei den von 1951—54 behandelten Patienten

	Anzahl Pat.	nach 1—4 Jahren symptomfrei	leben mit Met.	tot
Seminome	19			
mit Met.	5	1	1	3
ohne Met.	14	10	—	—
Embryonale-Karzinome	7			
mit Met.	1	—	—	1
ohne Met.	6	2	—	4
Teratome	1			
mit Met.	—	—	—	—
ohne Met.	1	1	—	—
Teratokarzinome	4			
mit Met.	—	—	—	—
ohne Met.	4	2	—	2
Chorionepitheliome	—			
Nicht-germinale Tumoren	2			
mit Met.	1	—	—	1
ohne Met.	1	1	—	—
	33			

Ansicht auf der Frühdiagnose wegen häufiger Untersuchungen der zum Wehrdienst einberufenen Patienten, der regelmässigen postoperativen Röntgenbehandlung und darauf, dass sich ihre Angaben nur auf die operablen Fälle beziehen. Ein weiterer Grund ist die höhere initiale Metastasenfrequenz in unseren Fällen, die wiederum mit der Frühdiagnose in Zusammenhang steht.

Tabelle 3 enthält die 1951—54 behandelten 33 Patienten, für die keine 5-Jahresheilung berechnet werden kann.

Die Mortalität von Seminomen und Karzinomen in den einzelnen Jahren nach Beginn der Behandlung während einer Beobachtungszeit von 5—24 Jahren geht aus Tabelle 4 hervor. Sie zeigt, dass die Tumorsterblichkeit nach 3—4 Jahren praktisch vernachlässigt werden kann.

Bei 14 % unserer Patienten ging ein Trauma voraus. 22 Patienten waren früher an Leistenhernien, Spermatocelen oder Hydrocelen der gleichen Seite operiert worden. Bei 12.1 % = 30 Patienten lag anamnestisch 28mal ein einseitiger und 2mal ein doppelseitiger Kryptorchismus vor. 18mal entwickelte sich hieraus ein Seminom. 4 Tumoren entstanden im Leistenkanal (2 Seminome, 2 embryonale Karzinome), 2 Tumoren im Abdomen (1 embryonales-, 1 Teratokarzinom). 3mal fand sich ein doppelseitiger Tumor ohne vorausgegangenen Kryptorchismus (2 embryonale Karzinome, 1 malignes Lymphom). In einem der Karzinomfälle war ein Bruder des Patienten 1 Jahr vorher an einem Terato-

Tabelle 4

Tumormortalität in den einzelnen Jahren nach Beginn der Behandlung bei einer Beobachtungszeit von 5—24 Jahren

	Seminome	Karzinome
3 Mon.	5	19
6 »	6	17
9 »	1	8
12 »	9+	12
1. Jahr	21 (50 %)	56 (67 %)
2. »	9+	12
3. »	2	6
4. »	4	2+
5. »	1	1
6. »	—	—
7. »	1+	—
8. »	1	2+
9. »	—	1
10. »	2++	—
11. »	—	—
12. »	—	—
13. »	—	—
14. »	1+	1+
15. »		—
16. »		—
17. »		—
18. »		1+
19. »		1+
	42	83

+ bezeichnet durch Obduktion bestätigten, interkurrenten Todesfall ohne Tumormetastasen.

karzinom operiert worden. 11mal trat eine einseitige, 4mal eine doppelseitige Gynäkomastie auf. Wahrscheinlich ist die wahre Frequenz höher, da nicht alle Fälle speziell daraufhin untersucht wurden. Sie trat meistens 2—6 Monate nach der Behandlung auf und deutet auf ein östrogenes Übergewicht hin. Die Gynäkomastie trat in unseren Fällen 4mal häufiger bei Karzinomen als bei Seminomen auf. Nur in 1 Falle lag ein Teratokarzinom mit Chorionepitheliomanteilen vor. 2 Patienten starben an einem Magenkarzinom 2 bzw. 14 Jahre nach Behandlung ihres Seminoms. Beide Fälle wurden obduziert.

Ein Patient war ein 51 jähriger maskuliner Pseudohermaphrodit, der wegen der femininen sekundären Geschlechtsmerkmale zeitlebens für eine Frau gehalten wurde. In Wirklichkeit lag aber ein Pseudohermaphroditismus masculinus externus et internus vor: Männlicher Wuchs, Bart und Körperbehaarung, weibliche Brüste und äussere Genitalien mit normalen Labien, 1 cm langer Klitoris und 9 cm langer, blind endender Vagina. Kein Uterus. Im li. Leistenkanal ein apfelsinengrosses Seminom mit kindskopfgrosser

Hydrocele. Der re. Hoden konnte im Labium majum in normaler Grösse getastet werden. Normale Androgenausscheidung, aber verminderte Östrogenausscheidung. Normale Prolan A-Werte. Keine abdominellen Metastasen. Nach Ablatio und postoperativer Bestrahlung 14 Jahre symptomfrei.

Das Material enthält 3 Fälle von nicht-germinalen Tumoren:

1. Mesonephric-Carcinoma, wahrscheinlich vom Rete testis ausgegangen. 52 jähriger Mann, 4½ Jahre lange Anamnese. Ablatio. Postop. Röntgenbehandlung in 2 Serien auf 2 Bauchfelder vom Skrotum bis zum Diaphragma mit der geringen Dosis von 2mal 800 r/Obfl. 7 Jahre ohne wesentliche Beschwerden, stirbt dann an multiplen Metastasen in Lungen, Pleura, Peritoneum und Leber.

2. Malignes Lymphom (Lymphoblasten-Lymphom bei einem 61 jährigen Patienten. Primäre Lokalisation in beiden Testes. Kokosnussgrosser rechtsseitiger und hühnereigrosser linksseitiger Tumor. Zuerst rechts-, nach ein paar Wochen auch linksseitige Ablatio. Faustgrosse Metastasen im re. Epigastrium verschwanden nach üblicher Röntgentiefentherapie mit 2,400 r/Obfl./28 Tagen auf 2 Bauch- und Rückenfelder vom Skrotum bis zum Diaphragma. Später Metastasen im Unterkiefer, Haut, Mediastinum und parenchymatösen Organen. Schneller Exitus. Bei der Obduktion sieht man neben einem grossen mediastinalen Tumor mit Pleurametastasen Milz-, Ventrikel-, Lebermetastasen und Ascites, aber keine Metastasen in dem röntgenbehandelten Gebiet der paraaortalen Lymphdrüsen. Die histologische Diagnose war anfangs unklar. Es schien sich zuerst um ein »wenig differenziertes, sarkomähnliches embryonales Karzinom« zu handeln. Nach der Obduktion zeigte es sich dann, dass ein wenig differenziertes malignes Lymphom vom Typ eines Lymphoblasten-Lymphoms vorlag. Der Fall zeigt, dass es manchmal unmöglich ist, undifferenzierte Tumoren verschiedener Stammzellen mit Sicherheit voneinander zu unterscheiden. Bei der Generalisierung des Tumors war es unmöglich zu entscheiden, wo der Tumor begann, seine erste klinische Manifestation war jedoch in beiden Testes.

2. Androblastoma tubulare lipoides bei einem ½ jährigen Knaben. Dieses wurde bei Operation der begleitenden Hydrocele entdeckt. Metastasen lagen nicht vor. Hormonbestimmungen wurden nicht ausgeführt. Nach Ablatio und Röntgenbehandlung auf 1 Bauch- und Rückenfeld über dem Epigastrium mit 1,050 r/Obfl./8 Tage war der Pat. symptomfrei. Bisherige Observation 2½ Jahre.

Metastasen. 80 von 247 Patienten = 32.5 % hatten zu Beginn der Behandlung klinisch manifeste Metastasen. Diese fanden sich überwiegend in dem regionären Abflussgebiet der Testislymphe, in den paraaortalen Lymphdrüsen im Meso- und Epigastrium. Teilweise waren sie auch generell, besonders bei infiltrierenden und weit fortgeschrittenen Tumoren. Die Lokalisation der Metastasen ist aus Tabelle 5 ersichtlich, der zum Vergleich die Ergebnisse von LINDGREN (38) sowie KELBY u. STENSTRÖM (35) beigefügt sind.

Die wahre Metastasenfrequenz bei Beginn der Behandlung war wahrscheinlich noch höher, da kleinere Metastasen nicht getastet und mikroskopische nicht entdeckt werden können. Parenchymatöse Metastasen sind im Endstadium sehr häufig, wie BARRINGER u. EARL (5) bei der Obduktion von 37 unbehandelten Patienten und AUERBACH, BRINES u. YAGUDA (3) an 26 mit Ablatio testis und Röntgen behandelten Patienten feststellten. In Barringers Material waren ⅓ der paraaortalen Metastasen bilateral. DIXON u. MOORE (16) haben eine Übersicht der

Tabelle 5

Lokalisation der Metastasen bei Beginn und während der Behandlung verglichen mit den Ergebnissen von LINDGREN, *sowie* KELBY *und* STENSTRÖM

Lokalisation	Met. bei Beginn der Behandlung		Met. während der Behandlung		Summa	LINDGREN	KELBY und STENSTRÖM
	Seminom	Übrige	Seminom	Übrige		36 Fälle	100 Fälle
Skrotum	1	4	1	6	12	—	—
Anderer Hoden	—	—	—	1	1	—	—
Fossa ovalis	—	1	2	1	4	—	—
Regio inguinalis	6	5	6	5	22	6	18
Lgl. iliacales	1	3	3	6	13	5	—
Paraaortale lgl.	26	35	7	18	86	20	30
Lungen und Mediastinum	4	22	13	31	70	21	18
Lgl. supraclavicul.	3	8	6	4	21	7	6
Skelett	1	3	3	5	12	3	—
Haut	—	—	2	3	5	1	—
Cerebrum u. Medulla	—	1	1	5	7	1	4
Orbita	—	1	—	—	1	—	—
Zunge	—	2	—	1	3	—	—
Leber	—	1	3	1	5	—	—

Tabelle 6

Lokalisation der Metastasen in den verschiedenen Tumorgruppen bei 36 obduzierten Patienten nach DIXON *und* MOORE

Lokalisation	Tumorgruppe				
	1	2	3	4	5
Paraortal und iliacal	71 %	96 %	100 %	92 %	100 %
Leber	54 %	80 %	83 %	70 %	—
Lunge	73 %	84 %	72 %	80 %	—
Niere re. 6 % li. 37 %	43 %	—	—	—	—
Nebenniere re. 9 % li. 35 %	44 %	—	—	—	56 %
Pankreas	21 %	—	—	—	—
Peritoneum	22 %	—	—	—	—
Pleura	17 %	46 %	35 %	33 %	—
Skelett	—	21 %	32 %	—	—
Gastro-intestinal	—	18 %	25 %	—	86 %
Gehirn	—	—	—	40 %	56 %

Metastasenverteilung bei 36 obduzierten Patienten der verschiedenen Tumorgruppen gegeben, die aus Tabelle 6 hervorgeht

Interessant ist die unterschiedliche Frequenz rechts- und linksseitiger Nieren- und Nebennieren-Metastasen, wobei es sich um ein direktes Überwachsen des Tumors von den perirenalen Lymphdrüsen handelt.

Schon TEILUM (50, 51) und LEWIS (37) wiesen darauf hin, dass die Metastasen der Testistumoren sich histologisch wesentlich vom Primär-

tumor unterscheiden können. TEILUM sah in 3 Fällen grosse paraaortale Chorionepitheliommetastasen, während der Primärtumor ein kleines adultes Teratom war. Er glaubt, dass es sich in solchen Fällen um eine frühe Metastasierung des noch nicht endgültig differenzierten Primärtumors handelt, der *in loco* zu einem adulten Teratom ausreift, sich paraaortal aber zu einem Chorionepitheliom entwickelt. MOORE u. DIXON glauben dagegen, dass es sich eher um einen Tumor mit verschiedenen Komponenten handelt, von denen eine bei der histologischen Untersuchung leicht übersehen werden kann.

In unseren Fällen fand sich ein embryonales Karzinom als Primärtumor, während die iliacalen Drüsenmetastasen ein ausgesprochenes Seminom ohne Karzinomanteile darstellten.

Behandlung

Nach den Erfahrungen der letzten 50 Jahre in denen konservative chirurgische (36) und radikale chirurgische Behandlung mit Ausräumung der inguinalen und iliacalen und evtl. perirenalen Lymphdrüsen (12, 29, 32, 37) wie auch radiologische Behandlung (6) erprobt wurden, ist heute die Ablatio testis mit Wegnahme des Vas deferens und der Gefässe unmittelbar distal vom äusseren Leistenring und die postoperative Strahlenbehandlung der Lymphstationen die Behandlungsmethode der Wahl für die Seminome. Karzinome und Chorionepitheliome können auf gleiche Weise behandelt werden, man kann sich aber auch wie LEWIS (37) zusätzlich zur Ausräumung der inguinalen, iliacalen und paraaortalen Lymphdrüsen entschliessen. Bei einer erstklassigen Operationstechnik ist nichts dagegen einzuwenden, doch ist zu bedenken, dass das seiner Lymphbahnen beraubte Gewebe empfindlicher für massive postoperative Strahlenbehandlung ist. Es dürfte auch unmöglich sein, alle Lymphdrüsen mit Sicherheit zu entfernen, zumal die paraaortalen und perirenalen beidseitig entfernt werden müssen. Die Ergebnisse von LEWIS sind auch trotz radikaler Operation nur bei den embryonalen Karzinomen besser als die unsrigen. Von 169 seiner radikal Operierten (davon 69 Seminome) hatten 24 operable Metastasen, 10 inoperable und 66 % waren ohne Metastasen. Nach einer Observationszeit von 9 Monaten bis 5 Jahren lebten von 250 Patienten noch 68 %. Keine Operationsmortalität, aber 14 Patienten starben an Strahlenschäden 1—2 Jahre nach der Behandlung.

97 % unserer Patienten wurden mit einfacher Ablatio testis und darauffolgender Röntgenbestrahlung der Lymphstationen behandelt. Die Übrigen waren inoperabel oder wurden radikaler operiert. Die Bestrahlung erfolgte auf die paraaortalen Lymphdrüsen von der Teilungsstelle der Aorta bis hinauf zum Diaphragma. Da die Einmündung der Lymphbahnen auf der linken Seite etwas kranialer liegt als rechts, wurde

links nur ein oberes Bauch- und Rückenfeld gegeben, während rechts zusätzlich ein unteres Feld über den iliacalen Lymphdrüsen bestrahlt wurde. Ausser diesen, in jedem Falle auch prophylaktisch behandelten Feldern wurden bei klinisch manifesten Metastasen anderer Lokalisation noch entsprechende Zusatzfelder gegeben. Eine routinemässige Behandlung des Mediastinum oder Halses geschah doch nicht, um den Pat. nicht zu sehr zu belasten. Wie die Untersuchungen von PENDERGRASS und Mitarbeiter (43) u. a. zeigen, verbessert dies auch nicht das 5-Jahresbehandlungsergebnis (5-Jahresheilungen = 42 %, davon mit Metastasen 30 % und ohne Metastasen 71 %).

Die Röntgenbestrahlung geschah unter folgenden Bedingungen: 180 kV, 20 mA, FHD 30—60 cm, $^1/_2$ mm Cu + 1 mm Al, bzw. Thoræusfilter 0.4 mm Sn + 0.25 mm Cu + 1 mm Al, HWS 0.80—1.8 mm Cu, 50 r/min. Feldgrösse 300—400 cm². 1 Feld wurde alternierend tägl. mit 300—400 r/Obfl. bis zu 2,400 r/Obfl. bestrahlt. In den früheren Jahren wurden meistens 2—3 Serien innerhalb 6—7 Monaten mit der gleichen Gesamtdosis gegeben. In einigen Fällen mit generellen Metastasen wurden Körperganzbestrahlungen bis zu 150 r/8 Tagen gegeben. In neuerer Zeit behandeln wir die retroperitonealen Metastasen auch mit dem Pendelgerät.

Bei der Behandlung des Epigastrium, die immer stationär durchgeführt werden sollte, kommt es oft zur Beeinträchtigung des Allgemeinbefindens und der Hämatopoese, die aber nur selten zum Abbrechen der Behandlung zwingt. Die strahlensensiblen Metastasen verschwinden meistens während der Behandlung. Im Gegensatz zu anderen Untersuchern haben wir keinen markanten Unterschied in der Strahlensensibilität der Seminome und der *wenig* differenzierten embryonalen- und Terato-Karzinome beobachtet und halten die Röntgenbehandlung in allen Fällen für indiziert.

Die klinische Symptomatologie ist unterschiedlich. In den meisten Fällen ist der Primärtumor dem Patienten bekannt. Da er oft langsam und schmerzlos wächst, wird der Arzt erst nach Monaten bzw. Jahren aufgesucht, wenn es bereits zur Metastasierung gekommen ist. Manchmal verbirgt sich der Tumor aber auch unter dem Bild einer Epididymitis bzw. Orchitis. Bei erfolgloser Behandlung mit Antibiotika oder beim geringsten Zweifel an der Richtigkeit der Diagnose sollte man eine Biopsie vornehmen. Auch Skrotalhernien, Hämato- und Hydrocelen können einen Tumor verbergen und sollten nach Möglichkeit operiert werden. Die seltenere Torsion unterscheidet sich durch ihre akute Schmerzhaftigkeit vom Tumor.

Bei einer kleineren Zahl von Patienten werden die ersten klinischen Symptome jedoch von Fernmetastasen, meistens perirenalen, retroperitonealen Tumoren verursacht (38). Die Diagnose wird dann erst durch

a b

Abb. 1. Kontrastuntersuchung der Vena cava inf. eines Patienten mit retroperitonealen, paraaortalen Metastasen. a. Deutliche Verdrängung der Vena cava nach rechts und vorn in Höhe des 2.—4. Lendenwirbels. b. 3 Monate nach Röntgenbehandlung 2,500 r/23 Tage (Herddosis). Normaler Verlauf der Vena cava nach Rückbildung der Metastasen. (Aufnahmen nach HELANDER u. LINDBOM.)

die Probeexzision geklärt. Man soll daher immer an die Möglichkeit eines primären Testistumors denken, der auch bei grossen Metastasen sehr klein sein kann. Während diese im Mediastinum, den Lungen und oberflächlichen Lymphdrüsen klinisch leicht nachzuweisen sind, können die paraaortalen zuweilen schwer sichtbar gemacht werden. Manchmal zeigt das i. v. Urogramm eine Verdrängung der Niere und des Ureters oder eine Stauungshydronephrose. HELANDER u. LINDBOM haben gezeigt, dass es in anderen Fällen möglich ist, die paraaortalen Metastasen mit Hilfe der Kontrastuntersuchung der Vena cava inferior nachzuweisen (Abb. 1).

Trotz ausgedehnter Metastasen gelingt es manchmal doch noch den Patienten mit der Strahlenbehandlung zu heilen. Natürlich sind die kurativen Aussichten um so geringer, je ausgedehnter die Metastasierung ist. Eine Tumordosis von 1,500 r wird von den meisten als ausreichend für die Seminome gehalten, während Karzinome meistens mehr benötigen

(2,500—3,000 r). Die Strahlensensibilität entspricht der Differenzierungsreife.

Rezidive zeigen sich bereits nach wenigen Wochen. Es kann zu Gefässstauungen in den Beinen und zu Kompressionen der Medulla kommen. Bei 3 unserer Patienten beobachteten wir metastatisch bedingte Querschnittslähmungen. Hohe Senkung, Rücken- und Bauchschmerzen, Erbrechen und Übelkeit deuten auf Metastasenrezidive hin.

Lokale Rezidive nach Bestrahlung beruhen oft auf zu kleiner Felderwahl und Einwachsen des Tumors von der Peripherie her. Später auftretende Metastasen können auf erneuter lymphogener oder hämatogener Streuung beruhen. Solch hohe Dosen wie LEWIS (37) sie beim Chorionepitheliom empfiehlt (5,000 r Tumordosis) wandten wir nie an und vermieden dadurch Magen- und Darmperforationen.

Chemotherapie. Kürzlich berichtete WILDERMUTH (53) über die Behandlung von Seminom-Lungenmetastasen mit Nitrofurazon, einem Furazin-Derivat. Der Patient erhielt vor 2 Jahren 49 mg in 4 Wochen (1.5—2.0 mg tägl.). Eine toxische Neuritis zwang zum vorübergehenden Aussetzen des Medikamentes. Die Metastasen verschwanden und der Patient ist nach 2 Jahren symptomfrei.

Die Behandlung mit Nitrofurazon fusst auf der interessanten Beobachtung, dass Furudantin, ein Harnantiseptikum aus der Furazin-Reihe, nach längerer Anwendung zur Atrophie der Spermatogonien führt. Wir haben bisher keine Erfahrungen mit dieser Behandlungsform.

Diskussion

Unsere 247 Patienten ergeben für die Tumorverteilung in der Gesamtbevölkerung keine absolut gültigen Werte. Als Spezialklinik erhalten wir unsere Patienten aus den Stockholmer Universitätskliniken und teilweise von weit entfernten Krankenhäusern. Nur der kleinere Teil dieser Tumoren kommt aus der eigenen Poliklinik. Dies hat eine Auslese nach 2 Seiten hin zur Folge: 1) erreichen uns die nicht-transportablen Patienten nicht mehr und 2) wird ein Teil der frisch operierten, klinisch metastasenfreien Patienten nicht sofort zur postoperativen Bestrahlung überwiesen, da der Operateur glaubt, den Tumor radikal entfernt zu haben.

Frühdiagnose, Ablatio und sofortige Strahlenbehandlung können die Behandlungsergebnisse wahrscheinlich verbessern.

Die *Metastasierung* erfolgt hauptsächlich auf den Lymphwegen. Diese ziehen vom Hoden mit der Art. und Vena spermatica durch den Leistenkanal zu den paraaortalen Lymphdrüsen, die sich von der Bifurkation der Aorta bis zum Diaphragma hinauf erstrecken. (Abb. 2.) Sie vereinigen sich dort zur Cysterna chyli und Ductus thoracicus, der im Thorax zur li. Vena subclavia zieht. Die paraaortalen Lymphdrüsen haben zahlreiche Anastomosen zur gegenüberliegenden Seite, sodass

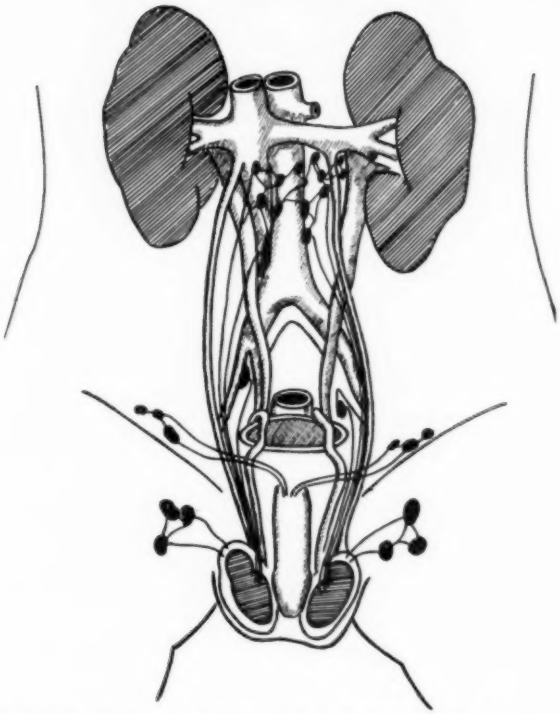


Abb. 2. Skizze über die Lymphabflusswege der Testis, Hodenhüllen und Peniswurzel (modifiziert nach ROUVIÈRE). Hauptabflussgebiet: die paraaortalen Lymphdrüsen mit Anastomosen zur Gegenseite. Daneben Bahnen zu der mittleren Gruppe der Lgl. iliacales externae (hier nur mit einer Drüse in den Iliacalgefässen angedeutet). Abflussgebiet der Hodenhüllen zur Fossa ovalis und Lgl. inguinales externae und der Peniswurzel in die Lgl. inguinales externae.

immer das gesamte Epigastrium behandelt werden muss. Ausser diesen Lymphwegen bestehen beiderseits Verbindungen von den Testis zur mittleren Gruppe der Lgl. iliacales externae in der Bifurkation der Art. iliaca (14, 31, 32, 47). In diese münden auch die Lymphgefässe des Nebenhodens und Vas deferens. Ausserdem finden sich direkte Lymphbahnen zwischen Testis und Epididymis (27). Wie aus Abb. 2 ersichtlich ist, besteht kein wesentlicher Unterschied zwischen rechter und linker Seite, wenn auch die etwas höher und lateral belegenen linksseitigen Drüsen in Parallele zur direkten Einmündung der li. Vena spermatica in die Vena renalis, einen stärkeren Metastasenbefall der linken Niere und Nebenniere verursachen (16).

Dieser Umstand darf aber nicht dazu verleiten, die iliacalen Lymph-

Tabelle 7

Metastasenfrequenz und Tumorwachstum bei Patienten mit ausschliesslicher Röntgenbehandlung über dem Epigastrium und späterem Auftreten von kaudal belegenen Metastasen.

Tumorart	Zahl	Metastasen zu Beginn der Behandlung	Durchbruch des Primärtumors durch Tunica albuginea, infiltratives Wachstum in Epididymis, Funikel od. Gefässen	Solitäre, wahrscheinlich lymphogene Metastasen
Seminome	9	4	2	8
Embryonale Karzinome	8	1	5	2
Teratome	—	—	—	—
Teratokarzinome	8	2	3	2
	25	7	10	12

drüsen der linken Seite bei der Behandlung zu vernachlässigen. Von unseren 109 mit 2—4 Feldern ausschliesslich über dem Epigastrium behandelten Patienten bekamen 25 = 22.9 % kaudal belegene Metastasen; davon 10mal iliacale, 15mal lokal im Scrotum, Funikelstumpf, Op.-Narbe od. in den Lgl. inguinales, 2mal in den Lgl. der anderen Seite.

Wenn auch ein Teil der Lymphdrüsenmetastasen hämatogen entstehen kann, so empfiehlt es sich doch, auf der Tumorseite immer das Abdomen vom Leistenkanal (einschliesslich) bis zum Diaphragma zu bestrahlen und das Feld dabei 5 cm über die Mittellinie hinaus auszudehnen, um die Anastomosen zur Gegenseite hin mitzuerfassen. Ob es derartige Anastomosen auch in Höhe der iliacalen Lymphdrüsen gibt, ist noch unbekannt, doch ist eine retrograde Streuung in kaudaler Richtung bei Blockade der paraaortalen Drüsen möglich und experimentell bewiesen (32). Operationsserien zeigen auch eine relativ hohe Beteiligung der inneren inguinalen Drüsen, wahrscheinlich auf Grund infiltrativen Wachstums (vgl. auch Tabelle 6, KELBY und STENSTRÖM). Bei Tumoren, die das Skrotum infiltrieren empfiehlt es sich, Skrotum, Fossa ovalis und Regio inguinalis mitzubestrahlen.

Für das Mediastinum gelten ähnliche Überlegungen. Es besteht kein Grund zur Annahme, dass die lymphogene Streuung am Diaphragma längere Zeit Halt macht, da es zu keiner Lymphstase kommt und der Übertritt der abdominellen Lymphe in den Thoraxraum in 3 Stämmen, im Gebiet der Art. mammaria int., im vorderen Mediastinum und paraaortal geschieht.

Von den 109 nur über dem Epigastrium behandelten Patienten bekamen 18 = 16.4 % mediastinale Metastasen (5 Seminome, 13 Karzinome). Nur in 6 dieser Fälle waren palpable Metastasen im Epigastrium vorhanden. Bei grossen und deutlich fühlbaren epigastrischen Metastasen dürfte daher die Behandlung des unteren Mediastinum auch

'prophylaktisch' indiziert sein. Natürlich muss jeder Patient individuell beurteilt werden, damit man ihm mit Rücksicht auf Allgemeinzustand, Blutstatus und Tumorwachstum mit der Bestrahlung nicht mehr schadet als nützt.

Aufschlussreich ist auch die Betrachtung der Patienten, die von Beginn an metastasenfrei waren, dann aber trotz Röntgenbehandlung später Metastasen im Behandlungsfeld bekamen.

Von 49 Patienten blieben 34 symptomfrei (26 Seminome, 4 embryonale Karzinome, wovon 1 Pat. mit Chorionepitheliomanteilen noch nach 19 Jahren symptomfrei lebt, 4 Teratokarzinome).

Fünfzehn Patienten bekamen generelle Metastasen, aber nur 1 Patient entwickelte Metastasen in dem röntgenbehandelten Gebiet über den Lgl. iliacales et inguinales.

Dieser hatte ausserdem Lungenmetastasen, weshalb eine hämatogene Streuung nicht ausgeschlossen ist.

Choriongonadotropinausscheidung und Prognose. Bei der Gonadotropinbestimmung im Urin muss zwischen follikelstimulierendem Gonadotropin der Hypophyse = FSH und Choriongonadotropin = HCG unterschieden werden. Reine Seminome sezernieren kein Choriongonadotropin, zeigen aber in 75 % eine erhöhte FSH-Ausscheidung = Prolan A von 50—400 Me. Dies kann die Folge einer verminderten Androgenproduktion sein, die bei diesen Patienten bis zu 1/5 der Normalwerte verringert ist, während das Prolan A normal ist. Zeigt ein Seminom aber eine erhöhte HCG-Ausscheidung, so liegt ein Mischtumor vor (24). Die Bestimmung des HCG leistet auch bei der Differentialdiagnose zwischen extratestikulärem Chorionepitheliom und Nebennierenrindentumor gute Dienste.

In den meisten älteren Untersuchungen wurde nur Prolan A bestimmt und die Resultate sind daher unbefriedigend und widersprechend (4, 18, 19, 22, 24).

Bei unseren Patienten ergab nach AHLBOM's (1) Mitteilung die Bestimmung von Prolan A und B bei 59 Patienten kein eindeutiges Resultat hinsichtlich der Prognose. 44 hatten normale Werte, 9 leicht erhöhte Werte und starben später an Metastasen, 6 leicht erhöhte Werte und blieben symptomfrei.

Wahrscheinlich sind die Resultate bei isolierter Bestimmung von HCG (38) zuverlässiger. Derartige Untersuchungen haben wir bisher nicht ausgeführt, werden dies aber in Zukunft tun.

Im Allgemeinen gilt eine HCG-Erhöhung als prognostisch ungünstig. Sie spricht entweder für ein Chorionepitheliom oder für Mischtumoren mit hormonproduzierenden Anteilen. Nach Entfernung des Primärtumors gestattet sie einen Schluss auf das Vorliegen hormonproduzierender Metastasen und kann im Verein mit anderen klinischen Untersuchungen für die Beurteilung des Krankheitsgeschehens von Bedeutung sein.

Blutsenkungsgeschwindigkeit und Prognose. Als prognostisch zuverlässig hat sich uns die Bestimmung der Blutsenkungsgeschwindigkeit erwiesen (1).

Patienten mit Testistumoren sind im Allgemeinen junge und im Übrigen gesunde Patienten. Beim Fehlen von Begleiterkrankungen haben sie nach der Ablatio testis eine normale Senkungsgeschwindigkeit unter 10 mm/Std. Alle Fälle in denen sich keine andere Erklärung für eine Erhöhung der Senkung über 20—25 mm/Std. findet, sind metastasenverdächtig und werden kurzfristig kontrolliert. Oft beobachtet man ein Absinken der Senkung während der Behandlung gleichzeitig mit der Rückbildung klinischer Metastasen.

Von 50 am Tumor Verstorbenen hatten 43 eine erhöhte Senkung über 15 mm/Std. Nur 3 hatten eine normale Senkung.

Von 108 Lebenden hatten 75 eine Senkung unter 15 mm/Std., 5 eine ungeklärte, erhöhte über 15 mm/Std. ohne spätere Normalisierung, 16 eine zu Beginn erhöhte, die sich nach der Behandlung normalisierte, 12 eine zu Beginn normale Senkung mit vorübergehender Erhöhung und endgültiger Normalisierung nach Behandlung in mehreren Serien.

Die Berücksichtigung der Senkung gestattet uns in den meisten Fällen eine gute und schnelle Beurteilung der Prognose und des aktuellen Krankheitsgeschehens.

Als weitere Zeichen einer guten Prognose gelten uns: Fehlen von Metastasen bei Beginn der Behandlung; Fehlen von infiltrativem Wachstum ausserhalb des Testis und Einbruch in die Gefässe; normale Choriongonadotropinausscheidung; guter Allgemeinzustand und normale Hämatopoese.

ZUSAMMENFASSUNG

Zweihundertfünfzig maligne Testistumoren bei 247 Patienten wurden 1921—54 am Radiumhemmet, Stockholm, behandelt. Von 214 Patienten mit einer Observationszeit von 5 bis 24 Jahren waren 50 % Seminome, 18.2 % embryonale Karzinome, 3.8 % adulte Teratome, 27.6 % Teratokarzinome. Nach 5 Jahren waren 108 Patienten (50.5 %) symptomfrei, 4 lebten mit Metastasen und 102 (47.7 %) waren tot.

Die 5-Jahresheilung der Seminome war 70.1 % (18.5 % mit klinischen Metastasen zu Beginn der Behandlung, 87.5 % ohne), embryonalen Karzinome 12.8 % (10 % resp. 16.5 %), Teratokarzinome 42.8 % (12.5 % resp. 60 %).

Als Standardbehandlung wird die Ablatio testis und die Strahlenbehandlung der Tumorseite empfohlen. In 12.2 % lag anamnestisch ein Kryptorchismus vor. Die ätiologische Bedeutung von Trauma, Kryptorchismus und Hormonen, sowie Besonderheiten der lymphogenen Metastasierung und die sich daraus ergebenden therapeutischen Folgerungen werden diskutiert.

SUMMARY

Two hundred and fifty (250) malignant tumours of the testis in 247 patients were treated at Radiumhemmet, Stockholm, in the period 1921—54. Of 214 patients with an observation time of from 5 to 24 years, 50 % had seminoma, 18.2 % embryonic carci-

noma, 3.8 % adult terinoma, and 27.6 terato-carcinoma. After 5 years, 108 patients (50.5 %) were symptom-free, 4 alive with metastases, and 102 (47.7 %) were dead.

Five-year cures of the seminoma cases were 70.1 % (18.5 % with metastases clinically at the beginning of treatment, 87.5 % without), of the embryonic carcinoma 12.8 % (10 % with and 16.5 % without, respect.) and of the terato-carcinoma cases 42.8 % (12.5 % with and 60 % without, respect.).

Removal of the testis and radiation therapy to the site of the tumour is recommended as standard treatment. There was a history of cryptorchism in 12.2 % of the cases. The aetiologic significance of trauma, cryptorchism, and hormones as well as the characteristics of lymphatic metastases, including those which follow therapeutic fulguration, are discussed.

RÉSUMÉ

Deux cents cinquante tumeurs malignes du testicule chez 247 malades ont été traitées entre 1921 et 1954 au Radiumhemmet, Stockholm. Sur 214 malades suivis pendant 5 à 24 ans, il y avait 50 % de séminomes, 18.2 % de carcinomes embryonnaires, 3.8 % de tératomes adultes, 27.6 % de tératocarcinomes. Au bout de 5 ans, 108 malades (50.5 %) n'avaient pas de signes fonctionnels, 4 vivaient avec des métastases et 102 (47.7 %) étaient morts.

Le taux de guérison de 5 ans des séminomes était de 70.1 % (18.5 % avec des métastases cliniques au début du traitement, 87.5 % sans); celui des carcinomes embryonnaires de 12.8 % (10 % avec et 16.5 % sans); celui des tératocarcinomes de 42.8 % (12.5 % avec et 60 % sans).

Le traitement standard recommandé est l'ablation du testicule et la radiothérapie du côté de la tumeur. Dans 12.2 % des cas il y avait une cryptorchidie. L'auteur examine l'importance étiologique des traumatismes, de la cryptorchidie et des hormones; il étudie aussi les particularités de l'envahissement métastatique lymphogène et les conséquences qui en résultent pour le traitement.

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PERIODIC CONTROL OF THE FUNCTION AND CONSTANCY OF IONIZATION CHAMBER DOSE METERS

by

R. Thoraeus

The international *r*-unit can only be realized by the use of a free-air standard ionization chamber designed in accordance with the definition of the unit. The fundamental importance of using a standard chamber being fully recognized, various types have been installed in standard laboratories and some radiotherapy centres. With such instruments quantitative radiation measurements in terms of the *r*-unit can be made with an accuracy of about $\pm$ 1 per cent, if all precautions are taken.

On account of its principle, a free-air standard chamber can only be used for measurements in a narrow beam of perfectly defined direction. Hence, it cannot be used for measurements of effective doses or dose rates (backscatter included), for instance in cavities, on the skin of a patient under treatment or the surface of a phantom irradiated, or conveniently as a portable instrument. A complete free-air standard chamber equipment is merely a laboratory standard instrument.

In most clinical and experimental radiologic work, however, measurements of effective doses, or dose rates, are chiefly met with. For such purposes ionization chambers of other types are necessary. They are usually designed on the basis of the small, closed ionization chamber. Since it has not been possible to cover the wide ranges of radiation qualities and dose rates by a single design of closed chamber, various types and sizes have been developed. However, most functional principles of the closed chambers are fundamentally different from those of a free-air standard chamber. For this reason the measuring properties of closed

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chambers cannot be safely foreseen, which in turn makes their design and construction both difficult and time-consuming.

From these facts it is evident that every dose meter provided with a closed chamber must be extensively calibrated against a free-air standard chamber to verify its measuring properties, and to define the range of radiation quality and angle, in which the readings are independent of wavelength and direction, so that the meter may be safely used. Later the calibration must be repeated at suitable intervals to check the function and constancy of the meter.

Such extensive calibrations of dose meters against a free-air standard chamber are, however, time-consuming and require the cooperation of at least one physicist and one technical assistant. Much time would therefore be saved by making such calibrations at relatively long intervals, taking intermediate checks of the constancy by a constant source of radiation, for example a radium gamma ray standard. Such a procedure may be considered perfectly safe if the method of checking used is sufficiently accurate and can be exactly duplicated, and if the instrument, in particular the chamber itself, is of appropriate design and reliable construction.

Several types of commercial dose meters have been available for a long time. Physicists who have sufficient experience in this field know, however, that substantial errors may occur in such meters. Consequently, such an instrument alone cannot be relied upon for radiation measurements in terms of the *r*-unit. It is, for instance, highly remarkable that many types of commercial dose meters are provided with a 'standard' to check the constancy of the instrument, but that this 'standard' only checks the operation of the counting or reading mechanism. The most fundamental part, *i. e.* the ionization chamber, and its function, lie completely outside any control. The fact is that in such a meter the chamber may be seriously damaged or even completely removed with the control by the 'standard' showing faultless and constant operation. It is quite evident that such a method of checking is completely meaningless and very dangerous in ordinary hospital practice. Instead of being an effective control, it permits the occurrence of serious faults in the radiation recording organ, the ionization chamber, without offering any warning. It should be stressed that any type of dose meter must be kept under continuous and minute supervision and expert control. Not until then may it be considered reliable, if otherwise of adequate design and good construction, and if used in the range of clearly verified measuring properties.

Hence, when a radioactive substance is employed to check the constancy of a dose meter, it should not be used as a source of charged particles, *i. e.* a constant electric current, by which only the function of the counting

or reading mechanism can be checked, but always as a constant source of penetrating radiation by which the meter's ionization chamber is irradiated. However, even if a radioactive substance is used in the last-named way to check the constancy of the whole meter, there are some important conditions that must be considered if a satisfactory result is to be assured. In the following the conditions are discussed, and a brief description of the method used at the standard laboratory of our institute is presented.

Access to radiation standards is in general of great value in experimental radiophysics. If properly designed, such a standard forms a constant source of gamma radiation, particularly valuable in checking the constancy of closed ionization chambers of various types. In both the roentgen therapy inspection section and the roentgen standard laboratory of this institute, the author has a number of ionization chamber dose meters which are routinely used. A reliable source of radiation is thus needed for the purpose mentioned. An ordinary radium container, temporarily used for a number of years, caused much trouble and was finally abandoned as unreliable for this purpose when the position of the radioactive substance in the container was found to be unstable. It was then decided to construct a special radium gamma ray standard. This is briefly described below.

In planning and designing the radium gamma ray standard the following general requirements of a reliable radiation standard were considered.

1. The material and thickness of the walls of the container must be accurately known, and selected to fit the type of radiation required from the standard.

2. The amount and chemical state of the radioactive substance must be precisely known.

3. The radioactive substance should be highly concentrated to occupy the smallest possible volume ('point source').

4. The radioactive substance must be kept in a reliable manner in a fixed position in the container.

5. The container must be made gastight, say by effective soldering, to prevent the dissipation of any kind of radioactive substance from the cavity in which it is enclosed.

For our particular purpose it was considered most convenient to use a radioactive substance of long half-life, the radiation output of which would not require frequent corrections. A radium gamma ray source was therefore decided upon. With such a source, however, all alpha and beta rays from the radium salt should be stopped by the wall of the container. A wall of 0.5 mm platinum would cover this requirement. Originally the idea was, therefore, to make the fundamental parts of the container of

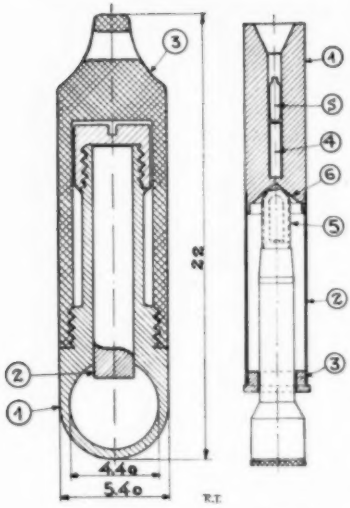

Fig. 1

Fig. 2

Fig. 1. Design of radium gamma ray standard. Fig. 2. Design of device housing the radium gamma ray standard and holding it in irradiating position.

pure platinum. However, from the point of view of machining a semisphere 0.5 mm thick with fairly high precision, an alloy of 90 per cent platinum and 10 per cent iridium was preferred. As far as the absorption of radium gamma radiation is concerned, this alloy differs negligibly from pure platinum.

The design of the radium gamma ray standard is shown in Fig. 1. The standard consists of two main parts, *viz.*, one made of the platinum-iridium alloy and containing the radium salt in a spheric cavity at one end (1), and a protective cap (3) made of chromium-plated brass and screwed to the first-named part. The gamma radiation of the standard is considered to give a well defined beam along the axis of the container.

The thickness of the semispheric front of the container was measured by a special micrometer. The result was 0.50 mm in the central region, gradually approaching 0.51 mm at the periphery. It is probably the best of its type and size which at present can be produced and be kept under minute control by direct measurements. The external diameter of the standard is 5.40 mm, and the total length 22 mm.

The radium salt of the standard was obtained from an old radium container filled in 1930 with radium sulphate. This salt was supplied by Radium Belge, and was guaranteed to contain 96 per cent pure sulphate. This has not been changed since then. In 1930 the container was certified to contain 50.8 ± 1.5 per cent milligram radium element. From the decay of radium it was calculated that the present amount would be 50.4 ± 1.5 per cent milligram radium element.

When the new standard was planned, it was found difficult to determine what space the available radium salt would require. To ensure that all the salt removed from the old container would go into the space provided in the standard, the space had to be designed with an additional margin of size.

The amount of radioactive substance removed from the old container and packed into the new standard was 74.4 milligrams. It was found that this amount did not fill the spheric cavity completely. The remaining small space at the top of the sphere was filled with powdered SiO_2. Both

the powders were firmly packed and kept in position by the cylindric plunger at the top of the sphere (see 2 in Fig. 1). The plunger was forced about 0.5 mm into the spheric cavity of the standard.

Assuming that pure radium sulphate contains 70 per cent radium element, the radioactive content of the new standard will be 50.1 milligrams radium element. This value is only about 0.6 per cent smaller than the value calculated above from the measuring result of 1930, and is thus within the measuring accuracy quoted.

The standard is usually enclosed in an aluminium container having a wall thickness of 0.5 mm and serving as a mechanical protection against wear and tear. This container has a screw-plug at the upper end, but does not form an airtight compartment.

Since a convenient and constant gamma ray source is now available, we have to consider the method of using it and the conditions required for a reliable result.

The conditions may be formulated as follows:

1. A well-defined beam from the standard must be used.

2. When a closed ionization chamber is to be irradiated, the radiation standard must be kept in a geometrically well-defined position in relation to the chamber.

3. The device used to house the standard in the irradiating position, and to keep it there for a desired time, must permit this procedure to be repeated with a high degree of accuracy on any occasion.

4. By selecting a suitable distance between the radiation standard and the ionization chamber in question, the time of exposure may be kept at a level ensuring reasonable accuracy.

The geometric form of the closed ionization chambers commonly used is rather simple, for instance cylindric or spheric, or a combination of these as in the thimble. On this basis a device to house the gamma ray standard, and keep it in the irradiating position, was constructed in 1951 from the design shown in Fig. 2. The device consists of three parts: a cylindrical rod of lucite (1) about 30 mm in diameter, and provided with a central hole in which a distance rod (4) and the gamma ray standard (S) are slid down; a brass tube (2) fixed to the lucite rod; and a guiding ring of aluminium (3) which fits to the stem of the chamber.

When the device described is to be used, the ionization chamber and its stem are arranged in a vertical position, and the device is then slid over the chamber in such a manner that the conical surface (6) at the lower end of the lucite rod is resting on the spheric top of the chamber. This arrangement permits the checking procedure to be repeated at any time with a high degree of accuracy.

The maximum dose rate is obtained when no distance rod is used, and the minimum when the distance rod keeps the gamma ray standard

at the upper end of the cylindric hole. The length of the distance rod may thus be easily adapted to the sensitivity of the dose meter in question. In this way it is usually possible to use exposure times sufficiently long (preferably at least 15 minutes) to ensure reasonable accuracy. Through the upper funnel-shaped expansion of the cylindric hole the standard is easily slid in when an exposure is to be made. At the end of each irradiation the gamma ray standard is quickly pulled out, the device usually removed from the chamber, and a reading taken. The time of exposure is taken from the moment when the standard reaches the bottom of the hole, or the top of the distance rod, to the moment when it is pulled out of the device. The gamma ray standard is handled either by a soft metal wire tied to the eyelet at the top of the standard, or by a thin rod handle screwed to the plug of the aluminium container. When the standard is not in use, it is stored in a thick-walled lead cylinder which forms a reliable protective barrier.

To illustrate the use of the method described, Table 1 shows a record of ten consecutive observations obtained with a secondary standard condenser dose meter. A distance rod 15 mm in length was used throughout the observations.

Table 1

Charging potential = 371 volts

Residual potential: Scale-divisions read on electrometer	Residual potential: Evaluated in volts	Drop in potential volts	Exposure time in minutes	Volts per minute corrected to 0° C and 760 mm Hg	Average
50.6	214.5	156.5	15	11.27	11.322 ± 0.4 %
50.4	213.2	157.8		11.36	
50.4	213.2	157.8		11.36	
50.5	214.0	157.0		11.31	
50.5	214.0	157.0		11.31	
38.2	162.2	208.8	20	11.28	11.318 ± 0.35 %
37.8	160.6	210.4		11.36	
38.0	161.6	209.4		11.31	
38.0	161.6	209.4		11.31	
37.9	161.1	209.9		11.33	

It is evident, however, that still more time would be saved if two or more chambers could be irradiated simultaneously. This is particularly easy to arrange with chambers the radiation sensitivity of which is about the same. In Fig. 3 a device for two chambers is shown, and in Fig. 4 a device for three chambers.

To irradiate more than three chambers simultaneously is, no doubt, possible. It would, however, save only a relatively small amount of time, but considerably increase the difficulties of constructing a device

by which the irradiation could be repeated with the same high degree of accuracy at any time. For these reasons an increase of the number of chambers above three has not been particularly sought.

The electrometer unit which the author is using to charge and read condenser dose meters has previously been described (1). For a number of years the sensitivity has been adjusted to about 3.8 volts per scale division, and is very nearly constant over all. The instrument scale has 100 divisions, each reading thus being read to $\pm$ 0.1 scale divisions, or $\pm$ 0.4 volt. The calibration diagram of the electrometer permits the same accuracy in evaluation of the potential values. Another electrometer unit designed by the author at the end of 1953, is shown in Fig. 5. The most characteristic feature of this instrument is that the electrometer is positioned at an angle convenient to the observer when sitting and that the latter, in manipulating the instrument and the condenser dose meters used, is always able to rest his elbows on the table. The angle may be selected to fit any particular purpose. The precision voltmeter available in this standard laboratory has been found to be correct within $\pm$ 0.2 per cent. From recent calibrations in England (2) and Western Germany, we have found that our unit of potential agrees with the units in those countries to better than $\pm$ 0.5 per cent.

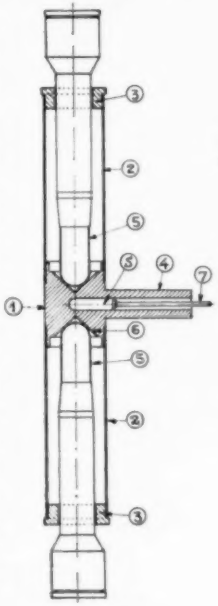

Fig. 3

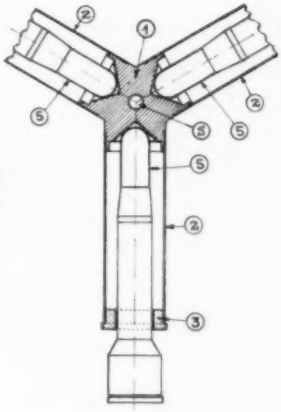

Fig. 4

Fig. 3. Housing device for irradiation of two chambers simultaneously. Fig. 4. Housing device for irradiation of three chambers simultaneously.

The devices shown in Figs. 2, 3 and 4 may be universally used for ionization chambers symmetric in relation to the longitudinal axis, and the transverse size of which is smaller than the inner diameter of the metal tube. For larger chambers, or for special types, devices more or less modified as to size and form may easily be designed. It may be mentioned that serial control of the commercial dose-meters used in the Roentgen Therapy Department of Radiumhemmet has been initiated with the device in Fig. 2 and the gamma ray standard described.

Fig. 5. Electrometer unit for charging and reading condenser dose meters.

When the device shown is in practical use, the operator's body need not come nearer the gamma ray standard than 70 cm, and remain at that distance for more than a few seconds when the standard is slid in or pulled out. At a distance of 70 cm from the standard the dose rate is 1.4 mr per minute. Assuming five consecutive exposures, each with a minimum time of 15 minutes, and intervals of 3 minutes for reading and charging, we obtain a total of 90 minutes for each dose meter, and find that a maximum of five meters may be checked in 8 hours. It has been found that the operator is exposed for 5 to 8 seconds at the beginning and at the end of an exposure, or for a total of about 15 seconds. From these figures it may be calculated that the operator will be exposed to a dose rate of 1.4 mr per minute for a total of 6.5 minutes in 8 hours. This corresponds to a maximum of 9 mr per day. Experimental measurements have shown that the daily quantity of radiation received by the operator under normal working conditions does not amount to 10 mr, and is thus well below the tolerance dose. If required, the device can be provided with a surrounding protective barrier, for instance of lead. Such protection will be necessary if sources of considerably higher radiation output are used. In such cases it may be advisable to invert the arrangement, for example by bringing a lead protected device of the type shown in Fig. 2 into a vertical position upside down, keeping the radiation standard fixed at the desired position, and sliding in the ionization chamber and its stem through the guiding ring so that the spheric top of the chamber rests on the conical surface of the lucite rod.

With the gamma ray standard and the housing devices shown, it has been possible to introduce and maintain a close check on the constancy of a relatively great number of dose meters. The working technique is fairly simple, and may safely be left to an experienced technical assistant. A short demonstration will enable him to start the work immediately and perform it alone. The relatively long exposure times necessary to obtain reasonable accuracy will also enable the assistant to do other work during the exposures, provided that both a signalling watch and a stopwatch are available.

Acknowledgments

The expenses associated with the new gamma ray standard, including re-packing of the radium salt, were defrayed by the *King Gustaf V Jubilee Foundation*, which also made the old radium container available for this purpose. Dr. A. FORSSBERG, biochemist at this institute, conducted the removal of the radium salt from the old container and the filling of the new container, and Mr. R. N. SCHEER of the Gustaf Rose Instrument Co., Stockholm, made the new container.

SUMMARY

The need and conditions of periodic control of ionization chamber dose meters are discussed. The arrangements used for such control, particularly a radium gamma ray standard and associated housing devices, are described in detail. The accuracy of the control obtained by these devices is illustrated by some measuring results.

ZUSAMMENFASSUNG

Der Bedarf und die Voraussetzungen der periodischen Kontrolle von Dosimetern für Ionisationskammern werden besprochen. Die für derartige Kontrollen benutzten Anordnungen, besonders eine Standard für die Gammastrahlung des Radiums und die zugehörigen Gehäuse werden in allen Einzelheiten beschrieben. Die Genauigkeit der mit diesen Apparaten ausgeführten Kontrollen wird durch einige Messungsergebnisse illustriert.

RÉSUME

L'auteur examine la nécessité et les conditions du contrôle périodique des dosimètres à chambre d'ionisation. Il décrit en détail les appareils utilisés pour ce contrôle, en particulier une source étalon de rayonnement gamma de radium et les dispositifs annexes destinés à la contenir. La précision du contrôle obtenue grâce à ces appareils est illustrée par quelques résultats de mesures.

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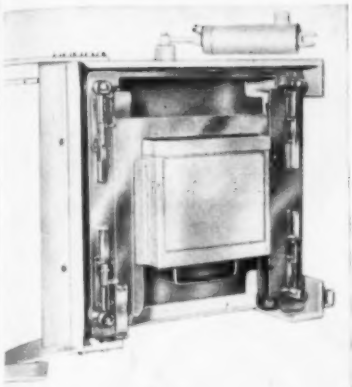

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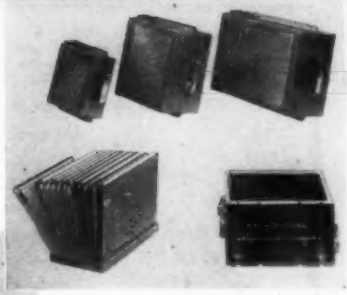

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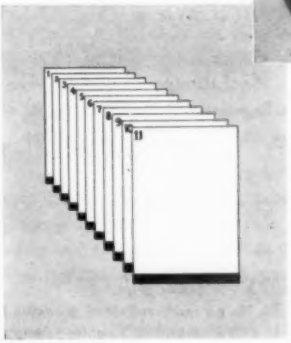

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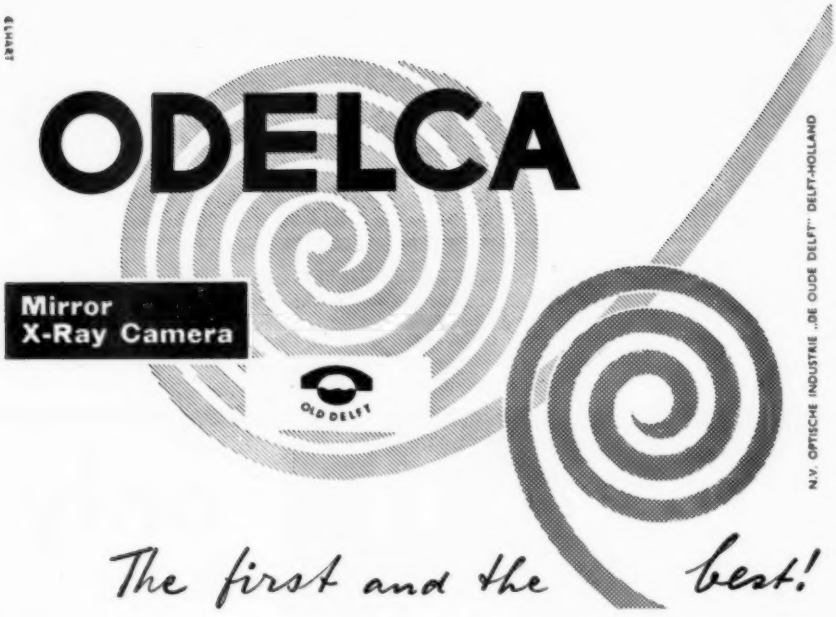

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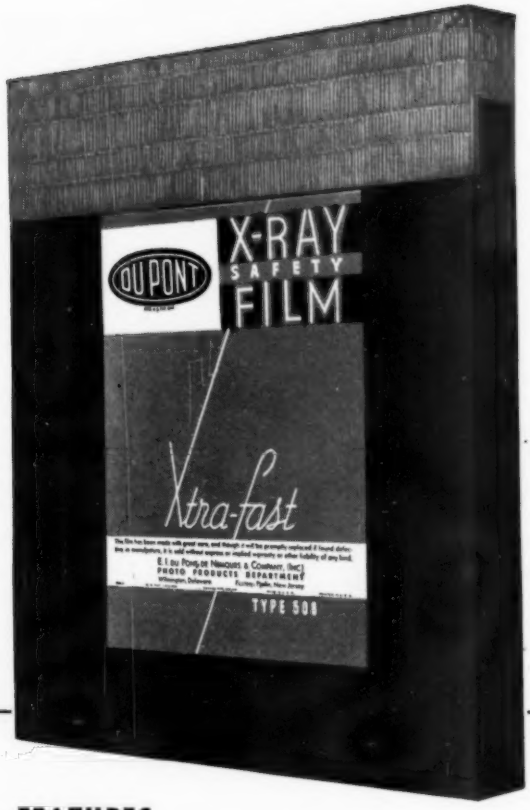

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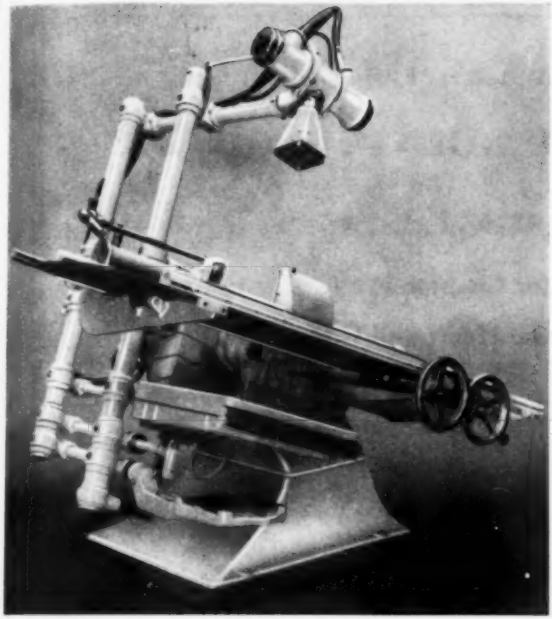

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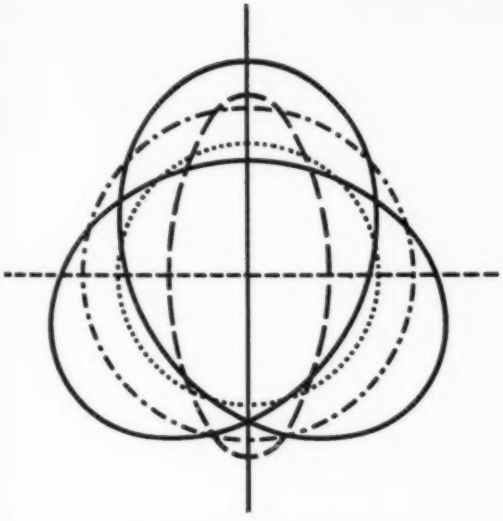

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